



RACE AGAINST FAMINE

MELVIN A. BENARDE

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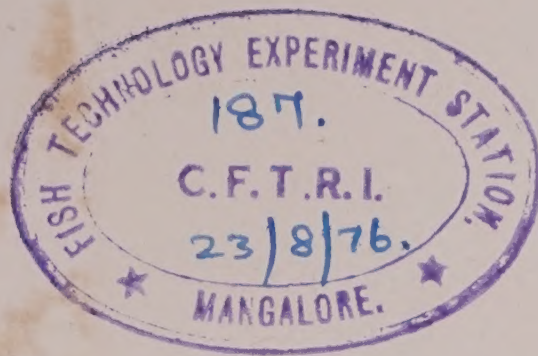
While political and moral dilemmas dominate the headlines of the world's public presses, we are largely ignorant of the problem of insufficient food and sky-rocketing population figures that lies like a time-bomb at our door. Here are the facts, starkly stated by Dr. Melvin A. Benarde of Hahnemann Medical College, who believes that it is time for young people to be alert to dangers too many adults overlook.

You don't have to be a scientist, Dr. Benarde believes, to read statistical graphs that tell the story. The plunging lines that indicate increasing poverty and alarming protein deficiencies spell disaster ahead unless man uses his resourceful mind and his clever

(see back flap)

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The destiny of nations depends upon the manner
in which they are fed.

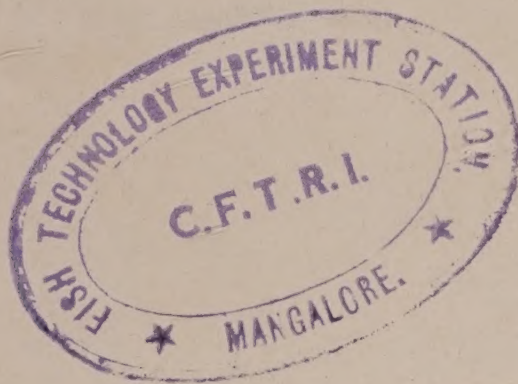
BRILLAT-SAVARIN

La physiologie du gout, 1825



Figure 1. Young girl in West Bengal, India, stuffs her mouth with a daily ration of CSM provided by CARE. Wide World photo.

Race Against **FAMINE**



MELVIN A. BENARDE



ORIENT LONGMAN

BOMBAY / DELHI / MADRAS / CALCUTTA

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For ANITA

and

SCOTT, ANDI, *and* DANA

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Chapter One

The Curves Tell the Story

TONIGHT, after a delicious dinner, most of us will go to bed content in the knowledge that a hearty breakfast will be waiting in the morning. Unfortunately, the full stomach that promotes this feeling of well-being is not shared by the more than a billion men, women, and children around the world who will fall fitfully to sleep, having had little more than some scrubby greens and perhaps a few gulps of a dishwatery liquid passing for milk—if that much. And tomorrow, if they are lucky, there will be more of the same. The fact is, half the world is hungry, and worse is to come.

The child shown in Figure 1, the frontispiece, is more fortunate than many others in India. She has been given a ration of “CSM,” a newly developed food supplement made of corn, soy flour and milk powder. But she may not get one tomorrow.

Although hunger, starvation, and famine have been known and feared since times immemorial, they are of greater consequence today than ever before because of the teeming populations that must now share the food supplies which are progressively dwindling in proportion to the population.

Think of it: ninety thousand babies are born each day. That's

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more than the current population of many of our cities. It's as if a new Abilene, Sioux City, or Orlando were added to the world each day—every day of the year!

As public health measures become more and more effective, more and more babies will survive to maturity, to give birth to still more babies, adding additional millions to the already burgeoning population.

Three curves tell the story of population, protein, and poverty: this one , this one , and this one . As might be suspected, these curves are actually graphic representations of populations.

When placed within boundaries, the character of the first curve reveals itself. Plotting numbers of people, in billions, against time, in years, a characteristic line or curve is obtained: and it speaks volumes. Figure 2 represents the general shape of the curve.

As Figure 2 shows, the world population doubled in the 1,700 years between the time of Christ and the middle of the seventeenth century. A second doubling occurred between 1650 and 1850, in just 200 years. By 1925, world population had doubled again in less than 75 years, reaching the 2-billion mark. In 1960, world population had passed 3 billion. If present rates of increase continue, and in all likelihood they will, the 4-billion mark will be attained in 1977, a doubling in 52 years. By 1987, just 19 years from now, there will be 5 billion people on the earth—and between 6 and 7 billion by A.D. 2000. Doubling time will have been reduced to less than 35 years.

According to the Food and Agriculture Organization of the United Nations (FAO), the annual rate of population growth is about 2 per cent. In some of the underdeveloped countries, growth rates are as high as 4 per cent. These may seem like very small numbers, without cause for alarm. But with a little knowledge of the workings of compound interest, you can see that these small numbers result in rapid and ever accelerating increases. A 2 per cent yearly growth rate doubles both money and people every 35 years, while a 4 per cent growth rate achieves a doubling in only $17\frac{2}{3}$ years.

The Curves Tell the Story

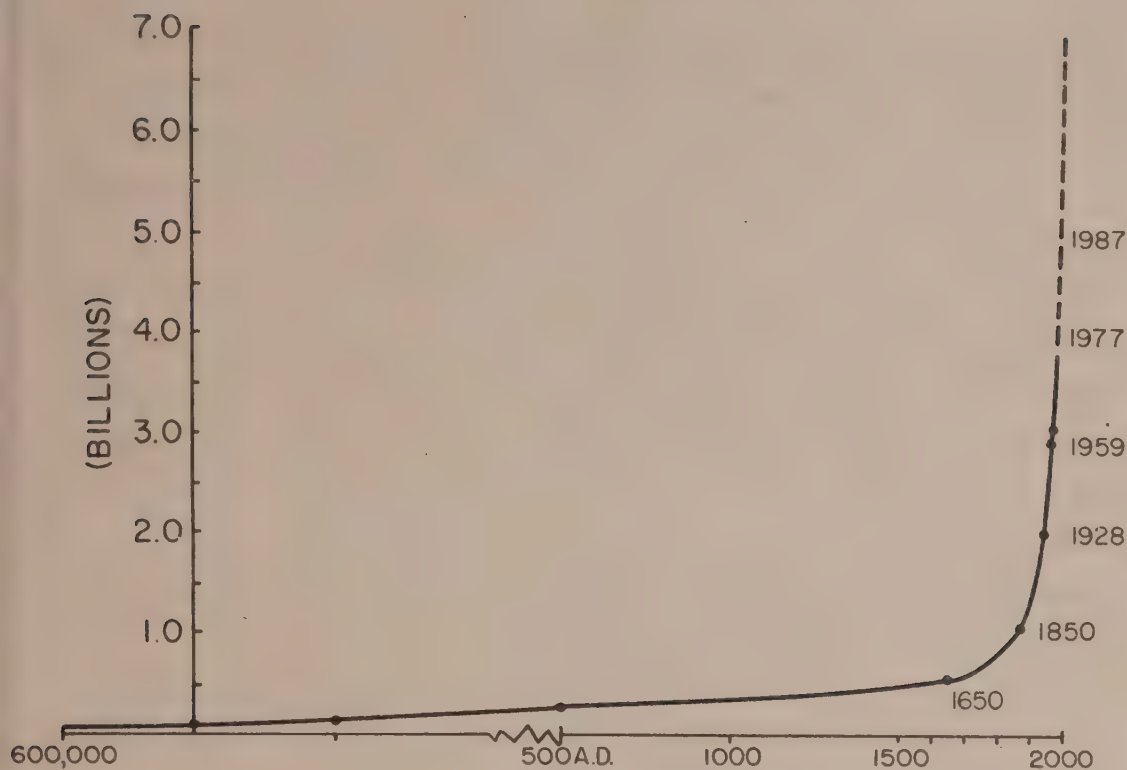


Figure 2. World population curve.

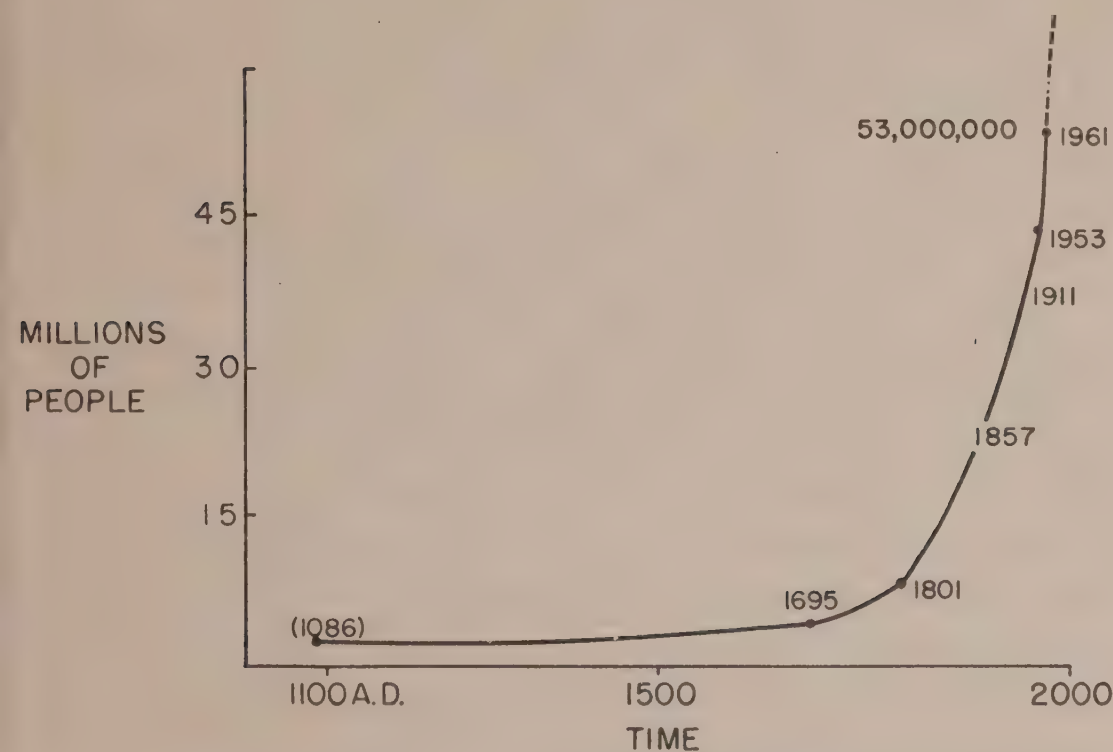


Figure 3. Population curve for England.

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Although doubling time will have been reduced by a factor of 50 from the beginning of the Christian era to the year 2000, the most disturbing increases have occurred within the past fifty years. It is this ominous trend that most depresses planners and government leaders.

Similar curves can be obtained when individual countries graph their population figures over several hundred years, if information before the nineteenth century, when many countries began a nationwide census, is available. The longer the time that adequate records have been kept, the more accurate and reliable is the curve.

Since 1801, when King George III wanted to know how many men he could put into the field against Napoleon, the population of Britain has been recorded every ten years. Before that time, the best available estimates were counts of the number of families, prepared for the Domesday Book (A.D. 1086) by the Norman conquerors, and an assessment of the number of hearths, carried out in 1695 by one Gregory King. Thus for the British Isles a population curve extending back some nine hundred years can be constructed with a fair degree of reliability. The curve, as seen in Figure 3, is almost identical with that for the world population.

Historians now suggest that the steady rise in population between 1600 and 1750 paralleled the widespread acceptance of the potato as a field crop; England, Scotland, Ireland, and Germany all began to plant potatoes about the same time.

The portion of the curves from 1850 onward, going almost straight up, can be said to be a "population explosion." Of interest is the fact that in the ninety years between 1756 and 1846, the population of Ireland tripled, rising from 3 million to 9 million. It was also during this period that some 2 million Irishmen migrated to the United States as a result of widespread famine caused by too much rain and the growth of a fungus that ruined the potato crop. (If first-hand accounts of life in Ireland during 1756 to 1846 are reliable, and there is no reason to believe they are not, the unspeakable poverty and famine did not affect fecundity and fertility as much as has been believed.)

The Curves Tell the Story

For the United States, the 1968 population of 200 million will have increased to over 300 million by the year 2000. For all practical purposes, the space you now occupy alone will have to accommodate a second person!

Concurrent with the rise in population in Europe and the United States came a development that was to affect the lives of all of us: the Industrial Revolution. This "revolution" not only changed the landscape for all time, substituting a manufacturing for a pastoral society, but it gave more people greater purchasing power. This fact is most important in understanding today's problems.

Doubling of population at least doubles the need for food, housing, fuel, sanitary installations (sewage and water treatment plants), schools, hospitals, and many other things that make a decent life. These things cost great sums of money.

The countries of the West underwent their population increases during the Industrial Revolution; they had buying power. Industrialization generated capital and stimulated productivity. As the population increased, needs could be satisfied and the countries prospered.

In today's underdeveloped countries, population has been increasing without the benefit of an industrial revolution. There has been no simultaneous generation of capital. The general rise in the standard of living that can support increased population has not occurred in the Middle and Far East, Africa, and Latin America. Inadequate food, shelter, and clothing is the lot of most of these people: in short, poverty. The Third World Food Survey conducted by FAO in 1963 clearly showed that 10 to 15 per cent of the world's people are undernourished and up to 50 per cent suffer from hunger or malnutrition or both. Population and food supply are directly related. (So are population and health, transportation, housing, water and air pollution, and urban sprawl, to note a sampling, but our concern is with population and food.)

There is now general agreement that unless world food production increases significantly, as President Johnson has put it, "All the combined production, on all the acres, of all the agriculturally productive nations, will not meet the food needs of the developing

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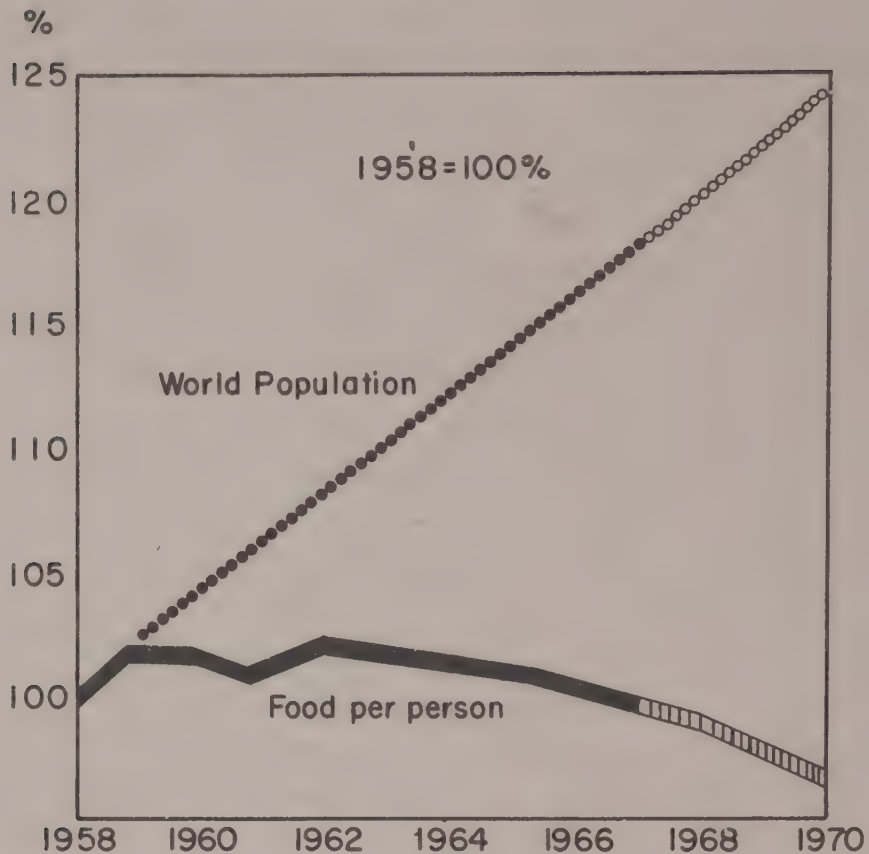


Figure 4. Population vs. food.

nations by 1985.” When President Johnson made this estimate, he may have had one stark fact in mind: fifteen years from now the world will have an additional billion people to feed!

What is at the root of the world’s food crisis? Simply stated, it is this: in most of the world’s underdeveloped regions, population has been increasing at a more rapid rate than food production. Look at Figure 4. By taking a portion of our world population curve, that piece between 1958 to 1967, and considering 1958 as our base line of 100 per cent, we see a 30 per cent increase in population by 1970. By the same token, the curve for the amount of food available per person has sharply declined.

A generation ago, Latin America, Asia, and Africa were regions with food surpluses. They exported grain to the industrialized countries, especially Europe. Now the food flow is reversed and they must import food. Since our Congress enacted the “Food for

Peace” legislation in 1954, food products valued at \$14 billion have been sent abroad. Despite this outpouring of our declining stocks, the line in Figure 4 has been curving progressively downward.

Latin America, for example, increased its total production of food over the last seven years, but the population increased by some 26 million people at the same time, so that the average individual had 7 per cent *less* to eat.

“The world is on the threshold of the biggest famine in history.” So spoke a former adviser to the government of India. “If present trends continue,” he said, “it appears likely that famine will reach serious proportions in India, Pakistan, and China in the early 1970’s; Latin America will fall into this category by 1980. Should this famine occur, it will be of massive proportions affecting hundreds of millions—even billions—of people.” The basic problem is that many Asian and African countries such as India, Pakistan, and the United Arab Republic simply cannot grow enough food to feed their expanding populations.

A bar graph is helpful in visualizing the problem. Figure 5 shows the percentage change in food production per person since 1939.

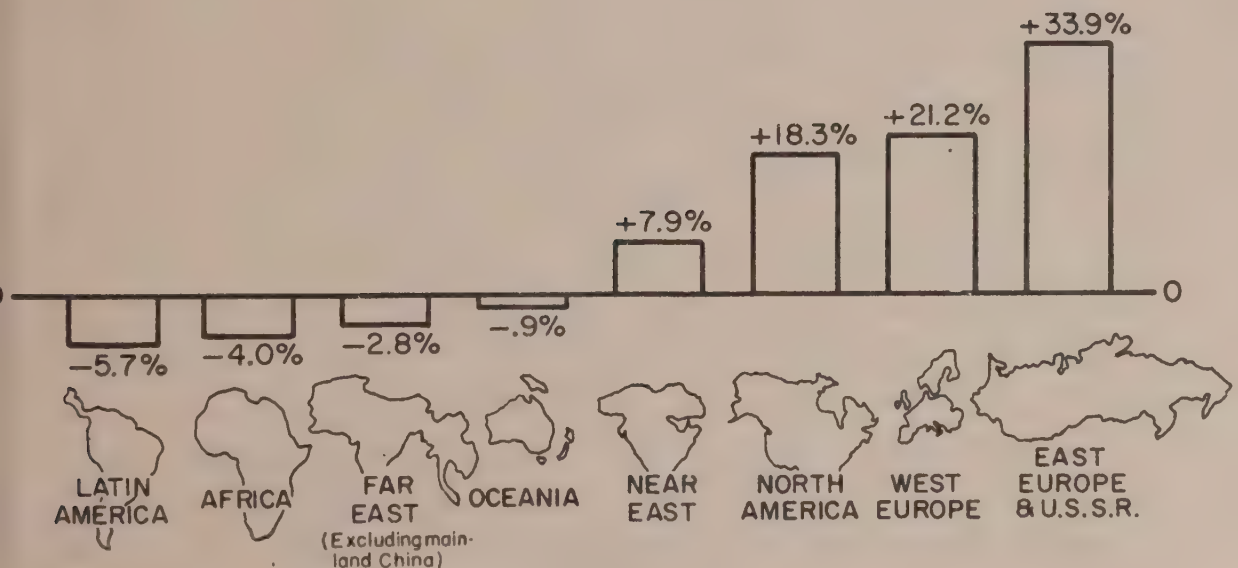


Figure 5. Change in food production per person since 1939.

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It is obvious that the world is split between the "have" and "have not" nations. This situation is aggravated by the failure of the countries most vitally concerned to correct the situation themselves. We have seen that many of these nations have been transformed from exporters to importers at a time when countries with extra food such as the United States are approaching the point where they will be unable to increase their exports much further. Experts agree that the underdeveloped nations cannot themselves provide the food they require. Where is it to come from? What kind of effort is required to bring technological advances to an underdeveloped country, and what are the consequences?

Consider, for a moment, a fisherman of a coastal village in India, Africa, or South America. Each morning, at first light, he is up gathering his nets, readying himself for the day's fishing. His boat may be large enough for one, two, or possibly three others. The distance they can go depends on their strength and endurance, and their catch will reflect their ability to paddle, row, or sail to prime fishing grounds.

These men can each bring home a small supply of fish. This is multiplied by the number of men fishing. When the total catch is brought to the beach shortly before dusk, it is usually bought up by the local population.

Suppose motors are now added to this situation, motors sent by more developed countries. The motors permit the fishermen to go as far from shore as they like, in search of large schools of fish. No longer are they bound by their limited physical ability. Now they can quickly reach the best grounds in less time and spend more time fishing. Of course, they will sharply increase their catch. Now, after the day's fishing, more fish are dumped on the beach than the local community can possibly use. They must either be sold or be allowed to rot. There are no refrigeration facilities—and high-protein foods spoil rapidly.

Some means of selling the large supply of fish to a wider market must be developed. Refrigerated storage rooms are needed, and refrigerated trucks must be brought in to haul the catch inland.

Let's back up one moment. Motors need gasoline, which means

The Curves Tell the Story

construction of large gasoline storage depots, and port facilities will be needed for tankers that carry gasoline. Motors also require trained mechanics to repair and maintain them. Refrigeration means sophisticated technical personnel to operate, repair, and maintain it. Selling fish means business channels for both wholesale and retail marketing; each warehouse and shop needs adequate cold-storage facilities to keep fish from spoiling. Without refrigeration, spoilage can occur in less than 24 hours in tropical countries. Adequate cold storage can extend the shelf life for weeks.

At this point the fishing village has disappeared. In its place is a highly mechanized fishing center whose environment and culture are completely altered. Can you conceive of the money needed to accomplish this transformation? It is staggering, but it will have to be found if we are to prevent world wide famine and starvation.

Thus far, the story in only one of three curves has been examined. Although the two remaining curves, this one , and this one , are related to the world population curve, they are unique in that they account for many of the current and long-term problems. While it has been pointed out that world population is increasing each year, it is important to note that all countries are not experiencing equal rates of increase. Most of the increase is occurring in the economically underdeveloped countries, where the death rate has remained high in spite of the many public health measures that seek to reduce it.

To say that population is increasing while the death rate remains high may seem contradictory. It is not. The fact is, that simultaneously with high death rates there are even higher birth rates.

For the most part, the high death rate occurs during the first year of life or before the fifth: periods of greatest vulnerability to infection. The many that do survive, however, are able to reproduce and add additional numbers to an already bulging population. As a result, when portrayed graphically the total population shows an almost perpendicular ascent—the population explosion.

Although a detailed discussion of population density, its causes and control, are outside the scope of this book, it can be stated with reasonable certainty that significant reductions in the rate of

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population growth and in absolute numbers to substantially increase per capita food supply will not be obtainable within the next 15-20 years. Thus, in spite of the many medical advances that have been achieved in conception control, the rate of population growth will probably continue to increase for some time to come.

The control of some of the major communicable diseases, such as malaria, has resulted in a sharp decrease in the deaths of children up to ten years of age. Thus the structure of the population in these areas shows a preponderance of young people. Figure 6 shows the numbers of people in underdeveloped countries by age groups. Approximately 35 per cent of the population is less than 30 years old. Notice the sloping character from age 75 down to the 0-14 age group: it is this  curve. By comparison, the population structure of a highly industrialized area, as seen in Figure 7, is quite different. It is this  curve, and it suggests that ours is a nation of older people. Less than 25 per cent of the population are under 30, while almost 15 per cent are 45 or over. In some countries half the population is less than 18 years of age. Today, 97 per cent of white females born in the United States live to 20 years of age; more than 90 per cent live to 50 years. It is obvious then that almost no woman dies before she has an opportunity to have children. A similar set of circumstances is well on the way to being true in many of the economically depressed areas. The reproductive potential is overwhelming!

A recent publication of the World Health Organization of the United Nations (WHO) points out:

There are two nutritional implications where the number of infants is high. First, during pregnancy and lactation the dietary requirements of the mother are greater than usual and second, for a good deal of this period the mother is prevented from undertaking her usual quota of productive work. She and her infant at this time are a liability to the community . . . and as public health measures become more and more effective, more and more children will, in all likelihood, survive into adult life if they can be fed. . . . Although increas-

The Curves Tell the Story

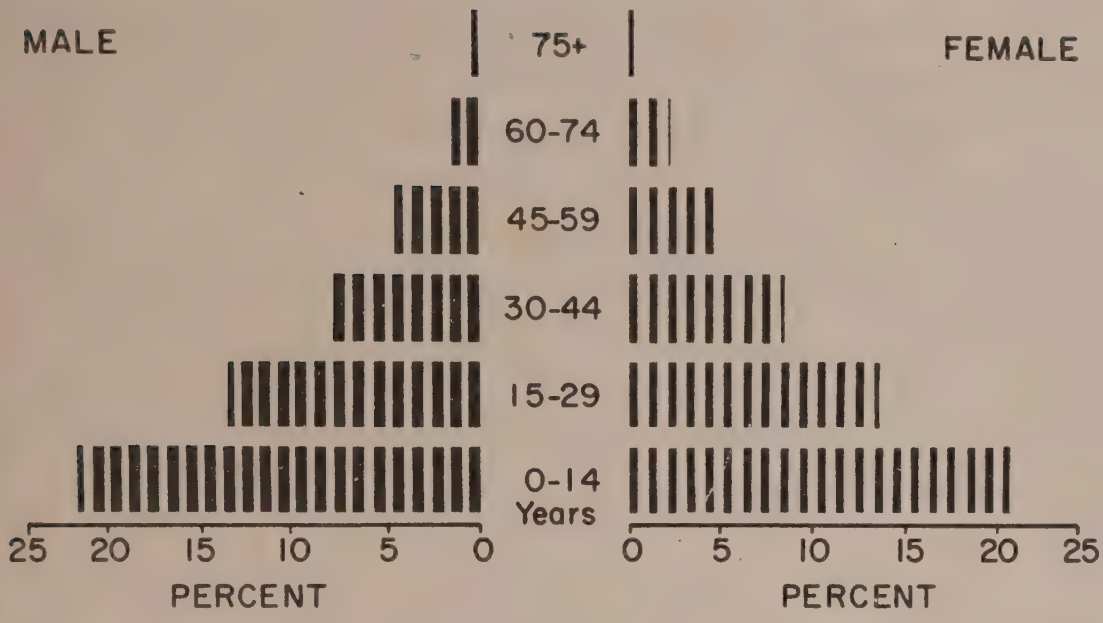


Figure 6. Age structure in underdeveloped countries.

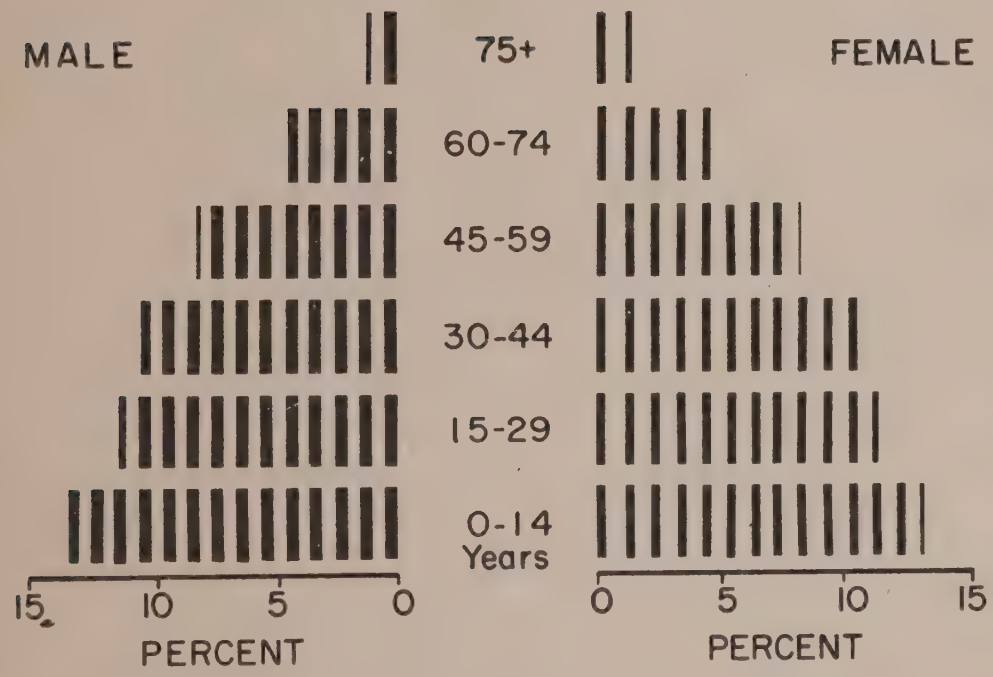


Figure 7. Age structure in North America.

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ing numbers of survivors may increase productivity and add wealth to the family and the community, the survivors themselves will beget children and add to the expansion of the population.

Increasing numbers of children of school age mean spending more money on clothing and education and less for food.

The lesson of history is that an increasing population, in the presence of decreasing or even fixed food supplies, gives rise to widespread hunger, malnutrition, and social unrest. What can be done about this? Let's look at Chapter Two.

Chapter Two

The Protein-Calorie Dilemma

WRITERS discussing the problem of food and population use the year 2000 as a reference point. At that time, some 6 or 7 billion people will be on hand and food supplies, if they are to be adequate, will need to be increased to more than three times their present level. The magnitude of the problem is staggering; some say it cannot be solved. Certainly, it presents a challenge to all who are concerned with the quality of living today and tomorrow.

It may be more to the point to note that *right now* someone dies of starvation every 8.6 seconds. That's something to think about! Every 60 seconds seven people die in the underdeveloped countries of the world as a result of illness provoked by malnutrition. That's 420 deaths each hour, 10,000 every day. Most of these are children. Some experts believe this condition will get worse. It is against this grim background that the means of increasing food supplies need to be reviewed.

Most of us know that lack of a balanced diet physically weakens people. There is a direct relationship between nutrition and work. Countries in which the food supply is low in both calories and protein are in trouble as compared to countries in which the food supply is high in both calories and protein.

Since Biblical times man has subsisted primarily on agricultural products. The main products of agriculture are carbohydrates, most particularly the starches and sugars found in potatoes, cereals, yams, and cassava. These provide little protein—up to 10 per cent. An adult man needs approximately 14 per cent protein each day to work productively, while children and pregnant women require from 16 to 20 per cent. The dimensions of the problem begin to take shape.

Let us first consider such terms as hunger, malnutrition, and undernutrition. *Hunger* is the same as *undernutrition*, an insufficient intake of calories due to an inadequate supply of food. If continued over an extended period it can lead to severe loss of weight and activity. In children, growth retardation often results. *Malnutrition*, on the other hand, refers to the quality of the diet: while the quantity of food available may be sufficient, it is deficient in some essential components; it may consist of overly large proportions of cereals and starchy foods such as potatoes and cassava, with too few of the protective foods such as meat, milk, fruit, and vegetables.

Undernutrition and malnutrition, often found together, are seen as chronic, long-term conditions that maintain individuals in a state of lassitude. The severest expression of an acute lack of food is starvation, and all too often malnutrition terminates in starvation and death.

Severe general malnutrition in infants and young children is known as marasmus or kwashiorkor. *Marasmus*, a severe protein-calories deficiency, is seen as a progressive wasting and emaciation of the body. Growth retardation is evident. Curiously enough, most acute cases survive. Figure 8 shows two views of a marasmatic child.

Kwashiorkor, another form of infantile malnutrition seen throughout the world, is the result of severe protein deficiency; calories do not appear to be involved. A term of the Ga dialect of Ghana, kwashiorkor has many interpretations; all, however, refer to lack of nourishment. It corresponds to the "sugar baby" disease in Jamaica and the "enfant rouge" disease of the Cameroons and is found under thirty-eight different names around the world.



Figure 8. Treatment of malnutrition: (left) a marasmatic child; (right) same child after ten weeks' treatment with Incaparina as the sole source of protein. Photo courtesy of INCAP.

In adults protein malnutrition is not so easily detected. Apathy, mental depression, lethargy, and lassitude are the sure signs, and the effects of chronic hunger with its steady drain of energy are epitomized in these lines well known in Eastern countries:

Better to walk than to run;
Better to sit than to walk;
Better to sleep than to sit;
Better to die than to wake.

Action is the last thing a hungry or malnourished person cares to contemplate. This tendency to avoid effort is known as *lethargy*. For most people in the underdeveloped countries, the daily diet is invariably deficient in proteins of animal origin and in calories. Recent studies by the Food and Agriculture Organization found that, after years of living on a deficient diet, "workers in these countries adapt themselves, at a low level of vitality, and with their powers impaired, to an insufficient ration, and scarcely realize that they are underfed."

As medical scientists have shown, poor diet is also directly related to lack of resistance to disease. In Guatemalan villages it was found that malnutrition and infectious diseases were the leading causes of death among preschool children, the researchers reporting that "accumulating evidence indicates a synergistic interaction between nutrition and infection. . . ." Among adults, a great deal of absenteeism from work, with its consequent loss of both wages and productivity, stems from illness caused by inadequate food intake. The undernourished worker also tires easily, which not only reduces his productivity but blunts his efficiency and increases the chance of accidents. Thus we see a straight-line relationship in which countries that have the poorest diets in terms of protein and calories are also those in which worker efficiency is lowest—with all the accompanying economic and social consequences.

Reduced productivity is not the only result of poor nutrition. Recent research suggests that the intellectual development of infants and children is impaired by insufficient dietary protein. A research team in Tlaltizapan, Mexico, is studying a group of children from before birth to the second grade. The suspicion is that poor nutrition and poor grades go hand in hand. It has already been found that inadequate diet depresses bone size and that the shorter the child the greater the lack of coordination between auditory and visual impressions. The poorer the coordination, the poorer the grades. The reason for this may be that a lack of certain essential amino acids, absent from low-quality proteins, may prevent normal growth of brain tissue.

THE ECONOMIC CYCLE OF DISEASE

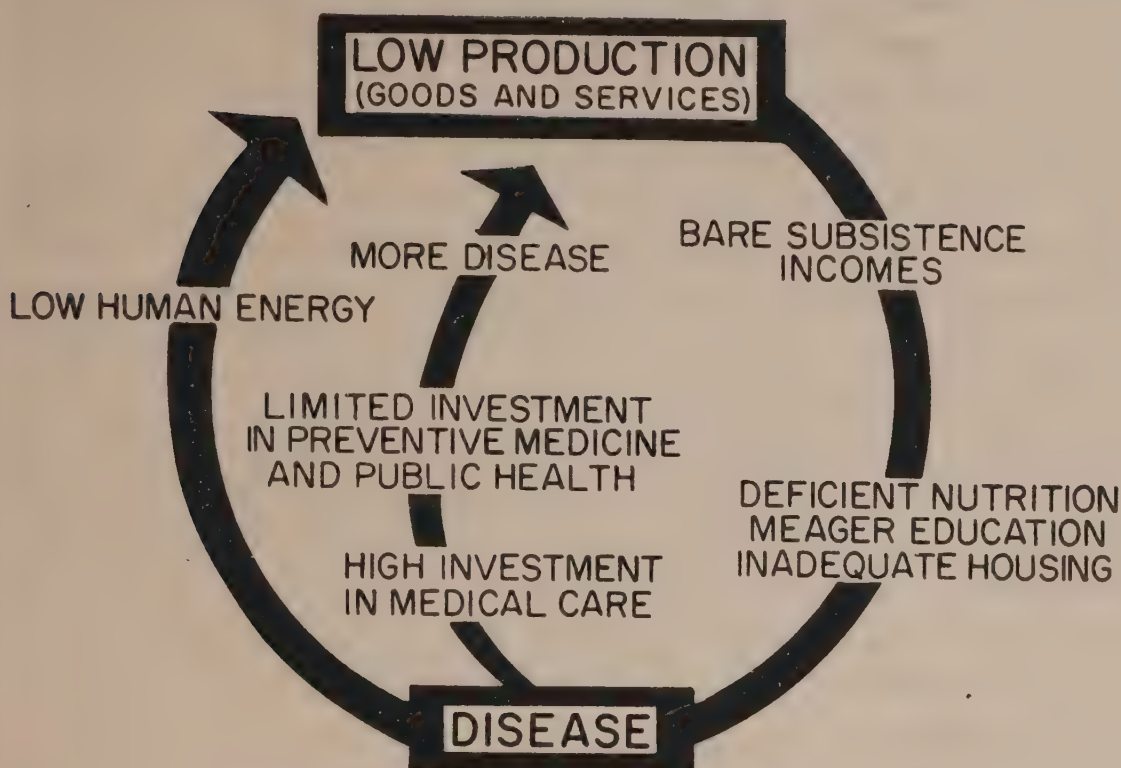


Figure 9. The economic cycle of disease. Adapted from A. Horowitz, Pan-American Sanitary Bureau.

Studies using laboratory animals, both in the United States and the Soviet Union, have shown that animals whose diets are deficient in certain amino acids are unable to thread their way through mazes as rapidly as their well-fed litter mates. Studies by Dr. John Dobbing of the University of London indicate that lack of adequate protein in the formative years prevents the full development of the myelin sheath that covers the nerve cells of the brain. How this physiological process relates to the learning process will take a long time to determine.

Malnutrition has thus been seriously underrated as a cause of death, illness, and impaired intelligence. We are now only beginning to witness an unraveling of the major role of nutrition in this grim triumvirate. Figure 9 graphically portrays these effects of poverty.

In discussing the quality and quantity of food available to the

general population in underdeveloped countries, comparisons are quite rightly made with diets in developed countries. Inevitably, however, such comparisons must face up to the protein-calorie dilemma.

Knowledge of the protein-calorie needs of various subgroups in the population, children, teen-agers, adults, workers in heavy industry, and child-bearing women, each with unique physiological requirements, helps gauge the dimension of the food gap in a given country.

The seeds of corn, wheat, rye, rice, barley, and oats, collectively called *cereal grains*, are stocked with special supplies of nutrients. Because they are relatively easy to grow and handle, they have served as the staple items of diet in many areas of the world for thousands of years. As they are the least expensive foods and, at the same time, supply the greatest amounts of energy per acre, some two billion people use them as their main source of calories.

In addition to these six grains, the white potato, sweet potato, soybean, peanut, coconut, banana, and cassava form the basis of the world's supply of edible plants. Think of it. After several thousand years of experimenting with about three thousand species of plants, only some thirteen are eaten regularly.

Although the human body is not a machine and should not be thought of as such, it does require energy. Just as the combustion of gasoline supplies energy to run an engine, the digestion of food provides energy for the articulation of muscle and bone. In both instances the energy supplied is measured in heat units—*calories*. To maintain our bodies between the 98 to 99 degrees Fahrenheit considered normal, some 2,500 to 3,000 calories are needed each day. Girls and women usually require the lower figure, while men and growing boys need the higher amounts.

In Figure 10, half the daily calorie and protein consumption of a North American and a Far Eastern diet are shown in meal form. The important ideas to note here are the calories obtained, the protein available, and the proportions supplied by animal and vegetable products. While both are fictitious "meals," they do indicate the major differences.



Figure 10. These two “meals” represent half the daily ration of protein and calories available to the average Far Easterner and North American. Note the vast difference in sources of animal protein. From *Science and Technology*, photo by John Hugelmeyer.

Although it is convenient to express the energy obtained from metabolism of food in calories, the primary purpose of the digestion of carbohydrate and fat is not simply the production of heat. Rather, it is to provide the energy needed to power the many oxidative chemical reactions technically called *metabolism*.

Each item of food supplies a specific and usually characteristic number of calories per unit weight. Some foods such as sugar contain only one kind of fuel, carbohydrate, while beef, for example, supplies two kinds: fat and protein. Milk, on the other hand, is one of the few foods to provide all three: carbohydrate, fat, and protein. Thus a diet of several foods will contain each of the three basic types of fuel, or *nutrients*, in varying proportions.

Professional nutritionists use the large Calorie (with a capital “C”), also known as the kilogram calorie, as an international

standard of measurement. It is the amount of heat needed to raise the temperature of one kilogram (2.2 pounds) of water from 15 to 16 degrees Centigrade.

The number of calories contained in any food can be measured in a bomb calorimeter or Benedict oxycalorimeter. In the bomb calorimeter, a weighed, dried sample of food is burned in oxygen. The heat evolved is transmitted to water and the increase in water temperature is used to calculate caloric value. With the oxycalorimeter, in place of water, the volume of oxygen required to burn a weighed sample of food is determined and the caloric value calculated from that. Laboratory studies with these devices have determined that carbohydrates generally yield 4 calories per gram, fats 9, and proteins 5. If we know the total carbohydrate, fat, and protein content in a food, we can calculate the total number of available calories.

One hundred grams of white bread, four or five slices, contain about 9 grams of protein, 53 grams of carbohydrate, and 2 grams of fat. By using the factors 5, 4, and 9 respectively, the numbers of calories per gram in these nutrients, we can find the number of calories in these four or five slices of white bread:

$$\begin{array}{r} 9\text{g} \times 5 = 45 \\ 53\text{g} \times 4 = 212 \\ 2\text{g} \times 9 = \underline{18} \\ 275 \text{ Calories} \end{array}$$

Table I lists several common foods and their caloric values, which were obtained in the same way. (This method of evaluating food does not measure any of its properties except approximate total energy. Digestibility, biological value, net protein utilization, and protein efficiency ration are not considered.)

Looking back at Figure 10, we note that the lion's share of the diet in the Far East—and this is most assuredly the case in Africa and in Central and South America also—is obtained from cereal grains and starchy roots, all low in protein. Although the pulses—peas, beans, and lentils—are rich in protein, they are difficult to

The Protein-Calorie Dilemma

Table I.

CALORIC VALUES OF SOME COMMON FOODS
(per 100 grams)

<i>Food</i>	<i>Caloric Value</i>
1 slice of pizza "with everything"	500
1 cup of popcorn	385
1 hamburger	250
1 banana	85
1 8-oz. Coke	100
1 cup of black coffee	4
100 grams potato chips	545

prepare and are not so widely grown and used as the grains. For example, soybeans, almost as rich in protein as beef, are native to China but have never become established in Central or South America. Curiously enough, although soybeans represent a major cash crop in the United States (we grow about 60 per cent of the total world output), most of it is fed to animals. Consequently, the more widely available cereal grains unfortunately have had to supply both proteins and calories. Furthermore, the meager protein content of these cereals is often of poor quality. Proteins vary; different kinds possess different physiological values.

When proteins are eaten, they are broken down, or *hydrolyzed*, in the digestive tract into their constituent amino acids. It is these amino acids, not the original proteins, that are absorbed into the blood stream for dispensing to tissue cells.

Although all proteins consist of bundles of amino acids, some of the bundles are not so complete as others and some proteins are not so digestible as others. Those the body cannot synthesize are considered "essential." Three of these essential amino acids (lysine, threonine, and tryptophane) are often lacking or present in inadequate amounts in cereal grains. The point here is that poor-quality protein foods may permit survival *but not growth*. Table II shows the protein content of some widely eaten foods.

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Table II.

PROTEIN CONTENT OF SELECTED FOODS*

	<i>Grams of Protein per 100 Calories</i>
Whole milk	5.4
Skim milk (dried)	10.0
Maize	2.6
Rice	2.0
Sweet potatoes	1.1
Soybeans	11.3
Cassava	0.8
Fish (fresh)	11.4

* Adapted from *Proteins: Their Chemistry and Politics* by A. M. Altschul, Basic Books, Inc., New York, 1965.

At this point, the full extent of the problem stands revealed: an abiding lack of protein, insufficient calories, and inadequate proportions of animal to vegetable foods.

Some years ago, the FAO Committee on Calorie Requirements set up reference standards for adults. A hypothetical "reference man" and "reference woman" were defined with respect to weight, age, physical activity, and the temperature of their surroundings. These "reference people" were healthy, consumed an adequate well-balanced diet, and neither gained nor lost weight—and of course they do not exist.

Reference man was calculated to need 3,200 calories per day for light to moderate activity, such as clerking or teaching (heavy work such as harvesting, fishing, mining, housebuilding, and stevedoring require upwards of 4,000 calories per day, an increase of from 30 to 40 per cent). Reference woman required 2,300 calories. Their energy expenditures during a day are shown in Table III. It is obvious that more vigorous exertion, such as that performed by Bart Starr or Johnny Unitas in a Sunday afternoon football game or by a coal miner or fisherman in his daily labors, will "eat up" a greater number of calories than the

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2,820 shown. Thus it will also be necessary to lay in a larger supply of fuel to avoid depletion and physical exhaustion. Obviously, the 1,500 to 2,000 calories available in some underdeveloped countries is very low.

The effect of calories on productivity was dramatically illustrated in Germany during World War II. At the beginning of the war, steelworkers' rations supplied approximately 4,000 calories per day. On this diet, each man produced about 120 tons per month. As the war progressed and food became scarce, food for the general population had to be severely rationed. Because of their importance to the war effort, steelworkers still received about 3,000 calories per day, a good deal more than the average. On this diet, however, steel production per man declined some 33 per cent to less than 80 tons per month.

Table III.

DAILY ENERGY EXPENDITURE BY REFERENCE MAN*

<i>Activity</i>	<i>Number of Hours</i>	<i>Calories Per Hour</i>	<i>Total Calories</i>
Sleeping	8	60	480
Sitting, reading, eating, driving, card-playing	6	90	540
Standing	6	150	900
Hiking and brisk walking	2	180	360
Occasional sports swimming golfing tennis	2	270	540
			2,820

* Adapted from *Recommended Dietary Allowances*, National Academy of Sciences, 1964. Used by permission

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Obviously, then, something must be done to augment or supplement locally available foods with high-quality protein and calories adequate for the work that needs to be done. Suggestions of ways to accomplish this are discussed in Chapter Three.

Chapter Three

Protein Supplements

IT IS EVIDENT that the world's main food crops need to be supplemented with protein. Where are these expensive items to come from? No country can really hope to emerge from an undernourished condition on the promises of foodstuff from other countries. Nor can existing methods of farming in the underdeveloped countries supply the needed supplements; present practices barely provide the subsistence diets currently available. Consequently, many new approaches are needed--and, with them, entirely new foods.

It must be constantly borne in mind when considering ways to increase protein supplies that the natural protein sources--meat, milk, poultry, and fish--are all highly perishable, particularly in tropical and semitropical countries. Consideration must be given to the many facilities needed to store, preserve, transport, and distribute these products to prevent costly losses. We have seen that each of these aspects requires trained people to maintain and service the technical refrigeration and processing equipment. Obviously, increasing protein in this fashion can be very expensive. However, adequate protein can be obtained in other ways.

Most Americans are familiar with Wheatena and Farina. At one

time or another most of us have eaten these “stick to your ribs” hot breakfast cereals. It is probable that Incaparina and Laubina are as unfamiliar as the other two are familiar. Certainly very few if any of us have tasted these new “made-up” food supplements.

When the grim statistic was made known that mortality among preschool children was up to fifty times higher in Central America than in Europe or North America, the Instituto de Nutrición de Centro America y Panama (INCAP) set out some fifteen years ago to explore the idea that locally available foodstuffs (not then eaten for a number of reasons including cultural taboos—see Chapter 6) could be used to prepare a low-cost protein and calorie-rich food supplement. Bear in mind that essential criterion—*low cost*. This immediately imposed restrictions on research efforts. Nevertheless, within ten years a vegetable-protein mixture had been developed, tested, and prepared for commercial distribution. This was Incaparina.

Incaparina is a mixture of cottonseed flour and whole ground cooked corn, with yeast, CaCO_3 , and Vitamin A added. It contains over 25 per cent protein, and there are 370 calories in 100 grams. This is comparable in quality to proteins of animal origin. From Table IV it is also evident that nutritionally a glass of Incaparina compares quite favorably with meat, milk, cheese—the more luxurious animal proteins. Currently, Incaparina is being sold in bags containing 75 grams, enough for three glasses. Not the least of its appeal is its price. A pound, enough for six glasses, can be purchased for 13 to 20 cents—just a fraction more than 2 to 3 cents per glass—within the means of everyone. Flavorings can be added to Incaparina and, if refrigeration is available, it can be consumed cold as a “colada.” In addition to drinking an Incaparina colada, the mixture can be incorporated into soups, pudding, cookies, and other nonbread items. The fact that Incaparina has the familiar odor of corn helps Indians to accept it. Figure 11 shows this acceptability. The formulations do not upset cherished cultural practices that are often the most difficult obstacles in breaking the poverty-malnutrition cycle. Having recently visited INCAP and seen at first hand the hearty acceptance of Incaparina by the

Table IV.

NUTRITIVE VALUE OF INCAPARINA AND OTHER PROTEIN SOURCES*

Expensive and Generally Unavailable
Animal Protein Sources

Nutritional Ingredients	ATOLÉ** INCAPARINA	ATOLÉ CORN MASA					
	<i>1 glass</i>	<i>1 glass</i>	<i>1 glass</i>	<i>1 ounce</i>	<i>1 unit</i>	FRESH CHEESE (whole milk) <i>1 ounce</i>	FRESH CHEESE (skim milk) <i>1 ounce</i>
Calories	138	86	141	36	80	79	38
Protein, g	6.9	1.0	6.9	6.4	5.6	5.2	6.3
Fat, g	1.0	0.4	7.6	0.7	5.5	6.0	0.5
Carbohydrates, g	25.3	20.2	11.3	0.6	0.5	1.0	1.6
Calcium, mg	164	22	374	6	26	235	206
Phosphorus, mg	174	22	168	52	95	112	100
Iron, mg	2.1	0.0	1.0	1.7	1.5	0.4	0.5
Vitamin A, I.U.	1,125	0.0	363	0.0	90	257	43
Thiamine, mg	0.58	0.02	0.08	0.02	0.05	0.01	0.02
Riboflavin, mg	0.58	0.00	0.50	0.07	0.20	0.13	0.16
Niacin, mg	1.95	0.19	0.10	0.79	0.04	0.04	0.06

* Adapted from INCAP Bulletin, Incaparina, May, 1965, revision.

** A glass of Atolé is prepared by dissolving 25 grâms of Incaparina ($\frac{1}{3}$ of a bag) in 8 ounces of water, boiling the mixture 10 to 15 minutes, and sweetening with 10 to 15 grams of sugar. It is customary to drink warm. Bringing the mixture to boiling conveys an additional benefit; destruction in the water of any pathogenic microorganisms.

youngsters in their villages, it is possible for the author to state that the program is well established and viable.

For a thousand years, the people of the Middle East have obtained their calories and protein from burghol, a parboiled wheat. For a thousand years, undernutrition has been a fact of life in this area. In 1961, Columbia University's Institute of Nutrition Research, supported by a grant from the U.S. Public Health Service, in conjunction with the American University of Beirut, initiated a research program to develop a protein-rich food supplement to combat the widespread malnutrition in infants and preschool children. Six years of trial and testing culminated with the announcement in 1967 that such a supplement, called Laubina, was ready for commercial production.

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Laubina (L stands for Lebanon and AUB for the American University of Beirut) is a mixture of wheat (burghol) and a local legume, *Cicer arietinum*, the chick-pea. Interestingly enough, chick-peas are high in protein, and the protein is of high quality. That is, it has a good amino acid pattern. Bone ash is used to provide a ready source of calcium and phosphorus, and sucrose and the complete daily requirement of vitamins A and D are included. Dried skim milk, while relatively expensive, is added to reduce further the wheat ingredient, increase the protein content, and replace the riboflavin lost by sun-drying the burghol. Two hundred grams of the mixture, approximately six ounces, supplies the total daily need for protein and all other food requirements, except total calories that can be obtained from other foods. In addition to the nutritive value, the protein content of Laubina is slightly better than leg of lamb.

The dried powder can be used in liquid formula for bottle feeding, can be thickened for spoon feeding, and can be sprinkled into thin soups and fruit juices. Despite its obvious nutritional value, however, it will be of no practical value if it is rejected by both parents and children. Thus far it appears to meet the low-cost requirement of the people as well as to fit into the cultural pattern of Middle East life.

Additional enriched vegetable protein products have been developed in other countries: Pro-Nutro in South Africa, Fortifex in Brazil, Panella in Colombia, and MPF and CSM in India.

For several years large quantities of skim milk powder have been sent abroad from the United States. However, the growing shortage of this relatively expensive item has curtailed its use in favor of less expensive and more readily available items. One of these, Marine Protein Concentrate (MPC) or, as it has more recently been designated, Fish Protein Concentrate (FPC), has recently come into its own. Until February 2, 1967, when the Commissioner of Food and Drugs permitted the addition of FPC in foods for human consumption, the Food and Drug Administration had con-

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sidered this flour, made from whole fish including scales, bone, and guts, “filthy” and unfit for human consumption.

Since 1950, when the pioneering work of Ezra Levin of the VioBin Corporation demonstrated that a high-quality “animal” protein concentrate could be produced, one obstacle after another has had to be overcome before this relatively inexpensive protein supplement could be offered to the public. The long, frustrating history of FPC development should give pause to those who suggest that new ideas are readily accepted and that new technological advances can be implemented almost as rapidly as they spring from the lips. On the day approval was finally granted, Secretary of the Interior Stewart L. Udall remarked: “The concentrate es-

Figure 11. A typical Guatemalan family drinking Incaparina. Photo courtesy of INCAP.



establishes a lifeline to a better future for undernourished millions of people throughout the world." While this may be true, it will still be some time before the flour is on its way to those who so sorely need it. For one thing, a demonstration processing plant must be constructed for the type of research that will demonstrate the feasibility of large-scale production before the flour will be certified for commercial production.

Early in the development of FPC, it became evident that a uniquely inexpensive food had to be produced if it was to be purchased by the people of underdeveloped countries. As the price of fish would be one of the most critical factors in establishing a selling price, several criteria were imposed. Only Atlantic red hake (*Urophycis chuss*) would be used as the basic raw material. It is abundant off the eastern coast of the United States and can be delivered to the processing plants without additional treatment. Hake is not widely eaten as a food fish and is available most of the year.

Essentially the production of FPC consists in removing water and oil from the raw fish and concentrating the solids to a level that increases the natural protein content from approximately 15 to 80 per cent. Most of the patented processes accomplish this by some form of solvent extraction, solvent residues being removed either by drying or by microwave radiation.

The final product has no fishy flavor or odor. It is in fact odorless and tasteless with the consistency of a fine, free-flowing, off-white powder, and it should sell for 25 cents per pound. Nutritionally, FPC is unique. It provides 80 grams of protein for each 100 grams of powder, and the protein is of high quality; its amino-acid content compares favorably with that of whole egg protein, which is generally recognized as the highest.

Thus far, nutritionists and dietitians have shown that FPC is readily accepted when added to bread, cookies, various types of macaroni products, soups, candy, and frozen desserts.

The low cost and high protein quality, combined with its ease of use in standard foods, should make a ready place for FPC in

many supplementation programs, if it is not rejected as “unfamiliar” by the women and men who need it most.

Concentrated fish protein is not a modern-day invention. The new wrinkle given to FPC is the chemical extraction that yields the fine dry powder. However, for hundreds of years a biological or enzymatic concentration of fish protein has been made by people of Southeast Asia. Although they are unaware of the mechanism by which the finely divided fish packed into earthen pots develops the flavor and consistency they so desire, it is in fact a simple enzymatic hydrolysis brought about by the naturally occurring microbial flora of the fish.

In Indochina, the semiliquid fermented fish is called *nuoc-nam*. For brave souls with a craving for gustatory adventures, similar products from the Philippines called *bagoong* and *tinabal* are available packaged in jars, in Chinese markets in New York and San Francisco. The Japanese prepare *shiokara* and *uwo-shoyu*; the Africans, *fessik*; the Burmese, *ngapi*; and the Pakistanis, *hidal knunda*. Each has a unique odor and taste but all are well calculated to leave most Americans gasping for air and running for the nearest rail.

With the swing to high-protein foods or supplements, nutritionists and food technologists have turned to the soybean. For more than four thousand years the soybean has nourished man; some authorities believe that China exists today because of it.

The superb food value of soybeans became well known only just before World War II. Its fantastic protein content is, pound for pound, four times that of eggs, fifteen times that of milk, twice that of chicken, three times that of lamb, and two and a half times that of beef. Equally important, soybean protein is a complete high-quality protein. Unfortunately, most ways of preparing soybeans have had little to recommend them. When cooked whole they require from three to four hours to soften and then are bitter and indigestible. The Chinese, with thousands of years' experience, have evolved elaborate cooking methods. Usually the softened beans

are mashed together with gypsum into a curd or a semiliquid preparation and allowed to undergo a bacterial or fungal fermentation to produce *tofu* and *natto*, two cheeselike products. The addition of wheat to the fermenting brew produces the familiar soy sauce.

Until the war years, this was the extent of soybean "technology." Then, as a part of the war effort, a soybean flour was developed. It was in fact more meal than flour, containing a high percentage of hulls and having a "beany," unpleasant flavor. The next development was a toasted product that disguised the beany taste with a burnt taste. To make matters worse, the heating often denatured the protein. Because of the ill-considered use of soybean "flour" as a response to wartime shortages, many people today harbor a poor opinion of it.

In the years since World War II, soybean use has virtually undergone a technological revolution. One of the most startling developments is the production of edible soy protein fibers that are spun on conventional textile equipment. The resulting fiber can then be processed into any kind of "meat" product desired. Textured Edi-Pro, a web of spun protein fibers, a product of the Ralston Purina Company, is shown in Figure 12. These tasteless, odorless fibers resemble silky blond hair. Treatment of beans with mild alkali extracts the protein. This is followed by extrusions through thousands of tiny holes in a platinum spinnerette into a coagulating bath where fiber formation occurs. It is at this point that fiber diameter can be varied from one to thirty thousandths of an inch. In addition, the "eating" character of the fibrils can be adjusted from "tender delicate fibrils to tough strands." For example, by orienting the fibers parallel to one another, a chewy texture can be obtained. By adjusting the spinnerette orifice and the composition of the coagulating bath to allow for the formation of a random mat, a "ham" loaf can be fashioned. Although the ribbons contribute protein and texture, they are only one of the ingredients needed to prepare a product. By adding coloring and flavoring, and by molding techniques, spun protein meats such as chicken, beef, sausage, and turkey loaf can be simulated.



Figure 12. A close-up view of the fibers of Edi-Pro. Photo courtesy of the Ralston Purina Company.



Figure 13. Bits of the textured vegetable protein, Edi-Pro. Photo courtesy of the Ralston Purina Company.

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The flavored bits shown in Figure 13 are only two of the many forms and uses of textured vegetable proteins. In powder form, they can be used for protein enrichment of bakery products, pancakes, soups, gravies, cooked and dry breakfast cereal, and infant and geriatric foods. Worthington Foods, founded by members of the Seventh-Day Adventist Church, has had a line of spun soy protein simulated meats on the market for several years. Such companies as Ralston Purina, General Mills, and Archer-Daniels-Midland, while producing the spun protein, plan to market their own items.

A typical analysis of the fibers is seen in Table V. For the present, the product must be considered too costly for export to underdeveloped countries, but in time it may assume its place.

Table V.

TYPICAL ANALYSIS OF SPUN VEGETABLE PROTEIN

	<i>Per Cent</i>
Protein (N $\times$ 6.25 dry basis)	95.0
Ash	4.0
Fat	0.2
Calcium	0.15
Phosphorus	0.65

pH (10% water slurry) 6.8

Dietary supplementation obviously plays a leading role in attacking the widespread problem of hunger, but there are other ways. The ocean has long been suggested as a great untapped potential food supply. Chapter Four considers the problem of food from the sea.

Chapter Four

Are the Oceans the Answer?

BECAUSE three quarters of our planet is covered by water, many people have suggested that within the ocean lies the bountiful answer to feeding the hungry people of the world. Hardly a day passes without an article in the press declaring the abundance of the ocean's depths and its potential for alleviating the chronic protein-calorie imbalance.

The amount of fish presently consumed per person each year (excluding Europe) around the world is about 22 pounds. (Europeans consume about twice that.) Although the amount of fish eaten is far smaller than the amount of other animal protein foods consumed, this may well be due to acceptability rather than availability. Many people simply don't care for fish.

In the United States, where relatively small amounts of fish are eaten, it is certainly not because fish is in short supply. Although large sums of money have been spent on advertising in an attempt to encourage the eating of fish, this has proved of little value; its acceptability remains at a comparatively low level. A similar low order of acceptability prevails in other countries. Therefore, simply increasing the fish supply is no guarantee of greater consumption.

Additionally, the fact that such countries as Peru and Chile have emerged as major fishing nations does not assure greater protein consumption for the people who need it. Both of these countries produce enormous quantities of fish meal from their extraordinarily large catches—in 1965 Peru landed 7.5 million metric tons of fish to become the world's leading fishing nation—but the largest portion of this meal is exported to the United States and Europe as a supplement to animal feed.

Until recent years, shrimp fishing was of little importance in the Mediterranean, and some people believed there were no worthwhile shrimp stocks available there. Shortly after World War II, however, French fishermen discovered substantial stocks of large shrimp. As a result, trawlers from Algeria, Egypt, Italy, and Turkey are taking these shrimp, and a very profitable trade has developed. But here, too, the relatively small portion available to domestic markets is reserved for well-fed nations with the necessary purchasing power. The bulk is frozen and exported to Europe and the United States.

In the past ten years the world-wide fish catch has increased some 54 billion pounds—from 60 to 114 billion pounds. Though the landed catch increased considerably, only a portion of this increase is considered edible. Thus the proportion used for food has declined from 80 to 60 per cent. For example, the large quantities of menhaden and hake included in the increase are used for processing into industrial oil, meal, or fodder by the more developed countries. Furthermore, increased harvests raise the problems presented in Chapter One—lack of markets, processing facilities, technically trained personnel, and many others. To increase one without simultaneously increasing the others is to invite wholesale waste that benefits no one.

Assuming for a moment that facilities could be built, though at a staggering cost, could the oceans' resources offer a regular and reliable food supply? What do the oceans contain that could augment the current species now being caught? It may come as a surprise, but it is none the less true that only a small fraction of the marine flora and fauna is used for food. Although zoologists

(ichthyologists in particular) have catalogued approximately thirty thousand species, less than 10 per cent are ever used for food, and of these less than half are used regularly or in any great quantity. Studying the tedious statistical collections does reveal the rather startling fact that about 35 per cent of the world's catch consists of herring and their cousins, the sardine, anchovy, and menhaden. (The latter two, remember, are used primarily for animal feed and industrial oil.) Codfish, hake, haddock, and pollack represent another 25 per cent of the harvest, while mackerel, bonito, and tuna account for some 10 per cent and flounder an additional 5 per cent. The remaining 25 per cent is made up of an assorted group of finfish and such invertebrates as the mollusks (oysters, clams, mussels, scallops), the crustaceans (lobsters, shrimps, crabs), and the cephalopods (squid, octopus, and cuttlefish). This is certainly not a big list.

Generations of experience in catching and selling fish have shown fishermen around the world just which of the creatures that enter their nets are edible, which will be eaten, and which must be considered "trash"—to be used in animal feed.

What is all this leading to? Essentially this: any scheme advanced for the purpose of closing the food gap must be able to do so *now*. *Now* is all-important. For the millions of hungry people, *now* means within the next five years—and even this is too long to have to wait for a decent meal. If five to ten years is our frame of reference, many of the fanciful technical notions put forward are of little immediate value. In this category are aquiculture, automated ships to process marine plankton, and "food" from petroleum and coal via selective microbial "farming." For those without food, flights of fancy are a poor substitute for a full stomach.

About fifteen years ago, great excitement was generated by many scientists certain that the large-scale cultivation of algae such as *Chlorella* would alleviate extensive protein deficiency. When, however, bread and rolls prepared from algae-supplemented flour were offered to test populations around the world, the baked goods were rejected straightway; no one cared to eat green bread or green rolls! After more than twenty years of extensive research and testing,

algal protein is still as far from alleviating the even more severe protein shortage that exists today than it was when first recommended.

A similar situation may exist with regard to the resources of the oceans. Although every depth of every sea has not been fully studied, it appears reasonable to assume that few if any new, adequately large, and regularly available marine populations acceptable as edible food will be discovered.

There are two crucial qualifications here: *adequately large* and *acceptable as food*. In general, food habits are deeply ingrained as part of a specific culture and are not easily changed or dislodged. Most people are repelled by strange-looking "foods." A generation could easily elapse before a population would accept a newly discovered species.

The vast protein resources of the oceans have been described not only as the answer to the problem of world-wide malnutrition but also as the "elixir of life" for sustaining any number of people the earth can hold. Theoretically, this may be correct; practically, it is an exercise in futility. It is one thing to develop fanciful arithmetic; it is quite another to produce and utilize what theory suggests is available. Overlooked is a fundamental fact: people's tastes in food are often quite unlike what scientific theory and calculation would like them to be.

Although significant increases in the number of tons of fish landed have been achieved over the past years, it has largely been a result of the use by developed countries of fishing vessels of advanced design employing highly sophisticated electronic fish-tracking gear. The print-out from one of these devices yields what looks at first glance to be the work of modern artists, but which in reality are time-frequency contour lines of acoustic reflections, each characteristic of a different species of fish. Acoustic target identification techniques, originally developed for submarine defense, have been modified for fishing needs. Different species of fish yield characteristic reflection patterns.

Much of the increased harvest also reflects increased tonnages of herring landed by the Danes and Norwegians as well as a three-fold



Figure 14. A trawler comes alongside a big factory ship, part of the Soviet floating city made up of fishing and supply vessels off the New England coast. Each factory ship processes the catch of ten to fifteen smaller vessels. Wide World photo.

increase in cod landings by Icelandic fishermen. During the same period the United States and the Soviet Union greatly increased their fishery capacity and their catch. Figure 14 shows one of the newest Russian factory ships. Recently the Soviets announced their intention to construct factory ships of 100,000 tons displacement—three times larger than anything currently afloat. Construction costs will run to many million dollars. While the Soviet Union has the capability in both manpower and money to build not one but a fleet of these ships, the less developed nations cannot afford to build even one.

One additional note. The Russians, in consultation with Belgian experts, have been considering the feasibility of installing Fish Protein Concentrate processing units aboard their factory ships. This would allow them to recover what heretofore was discarded as waste and at the same time increase their line of exportable

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products, which in turn would boost their financial position. But again, only a technologically advanced country can do this.

Meanwhile, in the same period, the less developed nations have barely increased their harvests. D. B. Finn, Director of FAO's Fishery Division, has pointed out that "in many of the underdeveloped countries of Africa, Asia, and Latin America, there are scores of thousands of fishermen who still use very primitive craft and gear. . . . Thousands of them use craft which are not suitable for mechanization as, for example, these catamarans are no more than a few balsam logs tied together and rigged with a sail. They can only sail on calm seas or in fairly good weather and can only fish for a few hours at a time." Unfortunately, vague calculations of potential resources do not account for conditions such as these.

A typical catamaran is shown in Figure 15. This primitive craft has a strictly limited fishing range. Typical Ceylonese fishermen, without benefit of motordriven boats, pole home much larger vessels. When there is no wind for the sails, the men often pole as far as ten miles, frequently arriving too late for the one train that takes their raw fish to the markets in Colombo, the capital city.

On the recommendation of FAO experts, Danish fishing boats were brought to Ceylon as an experiment. Figure 16 shows one of these motor vessels. At the side can be seen a woven basket in which the small fish used as bait for tuna are kept alive. The use of a motorboat enables the fishermen to catch up to and stay with the schools of fish, thus permitting them to land a catch many times the amount normally brought home.

In addition to importing fishing boats, experts such as the naval architect from Switzerland shown with pipe in Figure 17 have supervised construction of motor-driven boats for specific local conditions.

Reasonable scientists estimate that the world-wide harvest of fish could be increased two or three times without seriously depleting breeding stocks, but that increases beyond this could probably not be maintained indefinitely. Many underdeveloped countries can substantially increase fish production, but plans to harvest the edible fish of the oceans must deal realistically with all of the technologi-



Figure 15. A typical catamaran with sail added, used by Ceylonese fishermen. Photo courtesy of FAO-UN



Figure 16. One of the Danish fishing boats introduced in Ceylon by the Food and Agriculture Organization. Photo courtesy of FAO-UN.



Figure 17. At Cochin, India, an FAO expert instructs fishermen on design and construction of a new type of boat to be used in the Laccadine Islands. Photo courtesy of FAO-UN.

cal, economic, and sociological ramifications of these schemes. The inescapable conclusion seems to require that underdeveloped countries undergo a technological revolution.

Although fishing the ocean depths may not prove as fruitful as some have forecasted, fish production at the local level can still be dramatically increased. In bays, estuaries, and lagoons, but particularly in ponds in Africa, China, Indochina (now divided into Laos, Cambodia, and Vietnam), the Philippines, Japan, India, and Israel, small-scale fish farming has obtained spectacular results. Growing fish in the back yard, so to speak, or in rice paddies in either sweet or brackish water, can provide higher yields of protein per acre than any known agricultural crop. In Uganda, yields of 2,000 pounds per acre have been documented, while in Japan yields of

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up to 8,000 pounds per acre in heavily fertilized ponds have been claimed. Admittedly, these are unusual harvests, but it is not unusual to obtain 1,200 to 1,500 pounds per acre.

To achieve these prodigious yields, all that is required is a pond with a dependable water supply and a small quantity of "the fish farmers' friend." The friend, originally from Africa, carries the mellifluous name *tilapia*. Tilapia, a small but hardy tropical fish similar to our sunfish, is one of the few mouth-breeders, but with a slight twist—in this instance, it is the male parent that incubates the fertilized eggs in its mouth. Tilapia had no aggressive qualities. It lives peacefully with other species, feeding primarily on plankton, algae, or even on such unlikely provender as sweet potatoes, when available. Under the conditions usually provided in the two-to-four-foot-deep ponds—those in which light penetration is adequate to maintain growth of food organisms—the fingerlings, or fry, rapidly grow to 25 to 30 ounces in a year. A small tilapia is shown in Figure 18. Providing more favorable conditions by fertilizing the pond or lagoon with organic manures, including sweet potatoes, easily boosts the yield substantially above the average 1,200 pounds per acre. In heavily manured ponds in Japan, containing a mixed population of mullet and eels, yields up to 8,000 pounds have been reported. And this is high-quality, inexpensive protein.

Tilapia is not the only species to be used in pond culture. The milkfish, *Chanos*, is widely farmed in the Indo-Pacific region, while a catfish is favored in Thailand, where it is being farmed in high per-acre yields. In Malaysia, a giant freshwater prawn that can weigh up to three quarters of a pound is being farmed with great success. This is the type of creative advance that has *now* value. Culturing tilapia, *Chanos*, or catfish does not require an expensive technological revolution; it does provide high-quality food for large numbers of people who have little purchasing power.

Interestingly enough—and sadly, too—advances such as this do not escape the political struggle for the minds of men. On February 3, 1959, the *New York Times* carried a story from Vietnam describing how Communist propagandists, annoyed by the success-

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ful introduction of tilapia in the area, had tried to persuade the South Vietnamese that the fish caused illness.

By the middle of 1954, a majority of South Vietnam's population was refusing to eat tilapia or to allow the fish in ponds on their farms.

A program to tell the people the truth about tilapia fish by a word-of-mouth campaign was started to offset the Communist propaganda.

The counter-propaganda campaign gained momentum when poor people, who had continued to eat tilapia fish be-

*Figure 18. Haitian fisherman working in a tilapia-rearing experiment.
Photo courtesy of FAO-UN.*



Are the Oceans the Answer?

cause there was no other food available, failed to become ill as the Communists had claimed they would.

However, it was not until three years after the first rumors linking tilapia with disease, that the fish was widely accepted as a safe source of food.

Today, tilapia has regained its position as an important economic factor in Vietnamese life. Aid officials have distributed more than 1,700,000 of the fish to peasants throughout the country.

To many people, marine algae means seaweed. Surely this has little food value. It is curious that even though estimates of the amount of seaweed growing on the coasts of North European countries, France, Canada, and the United States are upwards of 60 million tons, none of these people have introduced seaweed into their diet. On the other hand, the Chinese and Japanese wouldn't be without seaweed. The Japanese annually harvest over half a million tons to satisfy their food needs.

Scientists classify marine algae into four groups on the basis of their most predominant color: green, blue-green, red, and brown. Only the red and brown have food value.

The value of algae to the food supply lies not in its content of protein or carbohydrate but rather in the minerals and vitamins it contains. For example, laminaria, one of the brown seaweeds, has been shown to contain 20,000 to 30,000 times more iodine per unit weight than the surrounding sea water. It also extracts and concentrates manganese, copper, and phosphorus, having 300, 200, and 500 times more, respectively, than the water in which it grows.

Carrageenin, the gelatinous extractive of Irish moss (which is neither a moss nor exclusively Irish), a red algae, is currently used in large amounts in packaged dessert mixes. Owing to its stabilizing effect with milk proteins, it has found a ready market in such milk-based products as ice cream, chocolate milk, evaporated milk, and a host of other items.

Unfortunately, although seaweed is widely distributed, it does

not have *now* value. It is extremely doubtful that people in under-developed countries could be readily converted to seaweed consumption even if it were made available.

No discussion of the sea's resources is complete without mentioning the place of oyster, mussel, and clam culture, all high-protein species. Of all the major groups of invertebrates—mollusks, crustaceans, and cephalopods—the mollusks, including oysters, clams, mussels, and cockles, offer the greatest opportunity for increasing the harvest of protein-rich food. The shores of all countries are populated by a variety of mollusks that can be easily and cheaply harvested. Yet, for reasons not well understood, these species are not widely used. Interestingly enough, although the British Isles, France, and the United States have long harvested extensive shellfish grounds, it is the Japanese who have become the greatest producers, harvesting close to a million tons a year.

To prevent overcrowding, to keep oysters away from such bottom feeders as oyster drills and starfish, and to increase yields, the Japanese have developed the technique of suspended culture. Basically, this consists of anchored floats from which ropes are hung that have been seeded with oyster spat. At intervals, the ropes are drawn up to determine oyster size and estimate harvest time. Figure 19 shows the essential features.

Similar use of suspended culture is made by mussel growers in Vigo Bay on the northwest coast of Spain. Unfortunately, although oyster and mussel culture has *now* value, meeting the essential criteria of ease of growing and harvesting, low cost, high yield, and high-quality food value, it does not appear to be attractive to populations unfamiliar with it.

In 1958, Lionel Walford, in his book *Living Resources of the Sea*, posed this problem: "Suppose it were feasible," he asked, "to finance only one kind of activity, what would make the most significant contribution to expanding the use of ocean resources in a protein deficient region?" He responded by saying, "Let us strike immediately at the heart of the problem . . . whatever kind of research is to be carried out will require scientists. There is a short-



Figure 19. Oyster culture. Photo copyright by Orion Press, Tokyo.

age of scientists . . . training men to be scientists is the heart of the problem.”

Ten years later, as if to emphasize this idea, John D. Isaacs, Director of Marine Life Research at the Scripps Institute of Oceanography, wrote that

in the end, after all is said and done, the political decisions made, the funds appropriated, the administrative and legal structures and super-structures erected, the investments made or stimulated, and the relevant technology developed and applied—even then, this edifice created to reap the potential protein harvest of the sea will rest on a scientific base that even now is far too undermanned to do the systematic biological research that must be done if we hope to reliably catch more fish and eventually farm parts of the sea. Biologists, taxonomists, paleontologists, ecologists, doing the

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undramatic 'dog' work in the field and in laboratories usually more reminiscent of the 19th century than the 20th, without fanfare or press releases, are the base on which the edifice rests. And they take a generation to train.*

That's the real bottleneck. Thus our original question stands: Are the Oceans the Answer? In terms of *now* value, it is doubtful.

* From *Science and Technology*, used by permission.

Chapter Five

The Benefits of Technology

H EAVY RAIN in January, February, and March is a regular occurrence in Indonesia. Ordinarily the low moisture content of grain helps preserve it, because most microbes cannot invade dry tissue. In Indonesia, because of a lack of adequate storage facilities, harvested rice spoils quickly in damp weather. As a consequence of the laws of supply and demand, the price of rice soars as the supply dwindles.

In January, 1968, the cost of rice in Jakarta jumped from 30 to 55 rupiahs per quart. At about the same time the increase was announced, the new school year began. Instead of attending classes, half the students took to the streets to mark their protest. Trucks, cars, buses, and taxis became mobile blackboards for chalk-wielding students who wrote on any available space, "We Love Rice, Give Us Rice."

Most riots are caused by unusual events. Since chronic lack of food is the rule rather than the exception, one would not expect a wide fluctuation in price to turn thousands of students out to intimidate the government. The fact that it did points up the changes that are occurring throughout the world. People in the

most inaccessible areas are beginning to realize that short rations do not have to be their daily fare.

Up to this point, we have been concerned with proteins and calories. There is another consideration, perhaps as important: increasing and protecting the total food supply.

In Chapter One, the food-population dilemma was spelled out. It was noted that, although birth rates remain steady or increase and death rates fall, yearly death rates are still as high as 25 per 1000 persons per year. This surely suggests that, with intensified medical and public health measures, further declines in death rates are to be anticipated. This implies lengthened life spans and even greater increases in population growth. Coupled with the fact that food production has stayed at the same level, this means that each person has less to eat. Without making a dire forecast of a coming world-wide famine, as others have done, we can clearly see that food production must be materially increased—now. It is as simple as that.

To go directly to the heart of the matter, we must ask: How can agricultural production be increased in the shortest possible time? Four courses present themselves: the use of fertilizers, improved seeds, irrigation, and pest control.

In 1962, according to the FAO's *Production Yearbook*, Ethiopia produced 440 pounds of wheat for each acre planted. Brazil did little better 475 pounds per acre. India, a major user of wheat, produced 760 pounds per acre. By contrast, production in the United States, Japan, and Denmark reached 1,440, 2,450, and 3,700 pounds per acre respectively.

Rice production followed a similar pattern; the Philippines, India, and Brazil, with 710, 870, and 1,020 pounds per acre respectively, were markedly lower than Japan, Italy, and Australia, where 2,720, 3,200, and 3,840 pounds per acre were harvested. Even though these large producers of grain are all highly industrialized countries, they are quite dissimilar in other respects. If underdeveloped countries followed some of the methods used to obtain these higher yields they should be able to double if not triple their production.

Given sufficient time, there is no doubt that every country in need could raise its agricultural productivity, but time is what there is least of. Widespread change to unfamiliar technical skills and methods by a less developed nation requires fundamental cultural changes and social dislocations. This takes time: at least a generation. During this changeover, population increase continues unabated. How will food production keep pace?

Of the many technical innovations, *increased use of fertilizer* has been shown to produce greater harvests most quickly. Field trials conducted several years ago by the FAO showed that the per-acre yield of such diverse crops as peanuts, cotton, beets, corn, potatoes, barley, rice, wheat, and a good many more could be substantially increased by the sensible application of fertilizer, other conditions remaining unchanged. Broadcasting 40 to 120 pounds of inorganic chemical fertilizers consisting of varying proportions of nitrogen, phosphorus, and potassium achieved increases of from 30 to 120 per cent. In summarizing its report of the field trials, the FAO Fertilizer Industry Advisory Panel said "there can be no manner of doubt that when farmers in developing countries use fertilizers—even without other improved farming methods—the results will be good."

Dr. Raymond Ewell, one of the foremost agricultural economists, stated that "if Asia, Africa, and Latin America are not using quantities of fertilizer approaching 30 million tons by 1980, they are almost certain to be engulfed in widespread famine." His grim prediction was that the underdeveloped countries would not be technically competent to manufacture even a fifth of this tonnage. Most of the necessary fertilizer will have to be supplied on credit by the developed countries. This immediately raises a question: Can 30 to 50 million tons of fertilizer be produced and shipped from the United States and Europe and sold to Africa, Asia, and Latin America? Are sufficient ships available and can the receiving countries afford the massive outlay of cash needed to purchase those chemicals?

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Here is what happened in the Philippines. Although 32.5 million Filipinos are dispersed throughout the 7,100 islands that comprise their nation, 90 per cent live on eleven major islands.

From 1957 to 1967, agricultural productivity in the Philippines was higher than for most other Asian countries, and per capita food supply kept ahead of the annual population increase. Unfortunately, this increase in food supply has been accomplished by bringing more of the previously nonarable land into production—but there is only so much available land.

It is important to bear in mind that, although rice is the mainstay of the Philippine diet, large quantities must be imported to meet demands. Rice production is far lower than in Japan, for example, where the farmers use 20 per cent more fertilizer than is used in the Philippines.

A survey conducted by Standard Oil Company of New Jersey, a major manufacturer of fertilizer, brought to light several pertinent facts: The great majority of farmers in the Philippines not only did not use fertilizer, but those who did, used it improperly and in amounts too small to be effective. Some of the reasons given for this were that fertilizers were too costly, that people were not told how to use fertilizers, that they could not get cash or credit to buy fertilizers, and that fertilizers were not available.

When proper guidance and directions were available, as shown in Figure 20, substantial increases in yield resulted. For example, on one farm, a paddy of rice was treated with ammonium sulfate, an inorganic chemical used as a source of nitrogen by richer farmers. Another paddy was sown with a more complete fertilizer, of the NKP variety, in addition to dressings of urea, in which nitrogen appears in organic form and is more readily available as a plant nutrient.

The plot treated with ammonium sulfate produced its usual 36 bushels per acre, compared with 76 obtained from the fully fertilized paddies. The additional cost of \$3.50 per acre for the additional fertilizer in the experimental paddies brought in \$132 in additional rice. Any farmer would find it difficult to turn down that kind of transaction. This should immediately suggest that



Figure 20. A Filipino technician demonstrates the proper technique of broadcasting fertilizer to a rice farmer. Photo courtesy of the Standard Oil Company (N.J.).



Figure 21. Two experimental corn plots. The one in background has had applications of complete fertilizer; the one in foreground was untreated. Photo courtesy of the Standard Oil Company (N.J.).

judicious application of the proper type of fertilizer has significant *now* value.

The benefits of sensible applications of chemical fertilizers can be seen in Figure 21. The corn plants at the left, planted at the same time as those on the right, which received no fertilizers, are far more developed and will supply a far greater yield per acre.

Significant increases in yield were obtained using seed varieties commonly available to local farmers. Had *improved seed varieties* been used in conjunction with dressings of fertilizer, the increase could have equaled that obtained by the most developed countries. Unfortunately, seeds developed for use in the highlands of Central America cannot be used in the tropical or semitropical regions of Africa, India, or the Philippines. Each country's unique topography, climate and soil means that plants must be developed to meet those unique conditions. Because this requires years of experimental breeding, selection, and crossbreeding, it must be considered, for *now*, a less beneficial means of improving food production than the application of fertilizers.

In November, 1967, when the Shah of Iran was crowned in one of the world's great displays of wealth, gifts of silver and gold arrived from dignitaries around the world—but not from President Marcos of the Philippines. In place of rubies, gold, and silver, President Marcos sent a bag of rice—not an ordinary bag of rice, but a bag of something called IR-8. “That bag,” said William G. Golden, an agronomist at the International Rice Institute in Los Banos in Luzon, in the Philippines, “could do more for Iran than all the jewels in the Orient.” We shall soon see why.

Rice-growing countries can be divided into two major groups on the basis of the type of rice they grow: *Indica* (long- or medium-grain rice) in the tropical and subtropical countries and *Japonica* (round grain) in countries of the temperate zone. In the United States, for example, *Indica* grows best in the southern states, while *Japonica* is the choice in Northern California. Figure 22 shows three major kinds of rice grains. Although they vary in size, all are of the same genus and species, *Oryza sativa*.



Figure 22. Three sizes of enlarged rice grains (*Oryza sativa*): top, long grain; center, medium grain; bottom, short grain. Photos courtesy of the U.S. Department of Agriculture. USDA photos.

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Soil, water, climate, and other factors limit the geographic distribution of rice varieties. If a variety is sensitive to light and heat, it cannot be interchanged between tropic and temperate zones. If a sensitive rice variety from Japan, for example, is introduced and grown in the Philippines, the shorter day and higher temperatures will produce a dwarfed plant that flowers prematurely, thereby producing little rice. On the other hand, a sensitive strain from the Philippines introduced into Japan, with its cooler, longer days, will either not flower at all or will flower late and similarly produce little rice.

When fully grown and ripe, ordinary rice stands 5 to 6 feet high. Often the long, weak stems cannot support the heavy rice heads. During heavy rains and high winds, particularly during the typhoons that are seasonal events in many islands of the South Pacific, the heads fall over and much of the rice is lost in water.

In 1962 the Ford and Rockefeller Foundations provided funds for the establishment of the International Rice Research Institute (IRRI) in Los Banos, to investigate the possibilities of upgrading per-acre yield of the common varieties of rice used in Asia and to develop more durable varieties. Researchers at the Institute set out to grow a plant with a heavy-yielding head that was shorter and tougher and could stand erect in high winds. In 1967, some five years later, after crossing a standard Philippine variety of rice with a dwarf Chinese type, IR-8 was born—IR for International Rice, and 8 for eighth strain developed. The people call it “miracle rice,” and perhaps that’s not far from the truth. Recall that in 1962 the Philippines produced 710 pounds of rice per acre; with IR-8 they now get 10,000—yes, 10,000!—it would appear to border on the miraculous.

For the Filipinos, this bounty ushers in their own private renaissance. Because rice is a major dietary staple and because it was chronically in short supply, large sums of much-needed dollars had to be spent on importing rice from abroad. IR-8 means an end to imports; all of the Islands’ needs can be home grown. In fact, tens of thousands of pounds of rice recently imported from the United States were sent off to Indonesia, since the rice was

no longer needed in the Philippines but was sorely needed in Jakarta.

Seeds of this new strain have been produced in substantial quantities and have been made available for commercial distribution. Almost all the rice-growing countries have received supplies, which has also been bred for insensitivity to variations of light and heat and can be cultivated in either temperate or tropical zones with no loss in yield per acre.

As with all such "miracles," all is not perfect. To produce its fantastic yields, IR-8 requires help: fertilizer, irrigation, and pesticides. These cost money, which is chronically in short supply. Also, mountainous areas in the Philippines and elsewhere are not conducive to growing IR-8. But it is only a matter of time before strains will be developed to meet conditions found at higher altitudes.

Scientists at the IRRI required about five years to develop IR-8 for high yield under varied geographic conditions. As yet they haven't succeeded in breeding a strain of rice resistant to blast disease. In more than sixty countries around the world, blast disease has been credited with producing losses of from 20 to 80 per cent in rice crops. This fungus disease, in which lesions in the necks cause the rice heads to break over, with the result that little rice is produced, is the most destructive disease of rice in Japan and is particularly serious in all humid countries. In the United States, Nova and Saturn, two medium-grain rice varieties, have been developed for resistance to blast disease. The available evidence suggests that building resistant stocks is probably the most promising line of attack against this infection.

Not so encouraging is the progress being made against *hoja blanca*, another disease specific to rice. Currently it is believed that *hoja blanca*, the white leaf disease, is a virus infection transmitted from plant to plant by a leaf hopper. White leaf disease was discovered in Florida in 1957 after it had ravaged the rice fields of Central America, destroying some 40 per cent of the total crop.

Rice is not the only crop receiving attention. Hybrid wheat developed at Mexico's National Institute of Agricultural Research

has been adopted by India and Pakistan. In Figure 23, an FAO expert in Libya, North Africa, supervises the weighing of barley in an experimental plot being developed for seed improvement.

One further aspect of cross breeding: Currently, a world-wide campaign for finding and saving wild plants urgently needed as breeding stock for future plant supplies is being pressed by FAO. This hunt is being carried out because the high-yielding hybrids in which many countries are placing their hopes are subject to diminishing returns. Hybrid plants, vegetables, fruit, and grains are subject to genetic deterioration. Like thoroughbred horses, they perform at peak for a time but need to be crossed with new stock to maintain their high level of performance over the years. Agronomists must constantly search for primitive plant species with which to provide these needed infusions. In order to prevent serious problems twenty years from now, scientists are currently pressing the search for these primitive forms, cataloguing and preserving them for future use. A World Catalogue of Genetic Stocks containing records of over 1,400 varieties of rice has been compiled and is regularly added to by the FAO.

An outstanding example of the international character of this work is supplied by Dr. S. W. Zagaja, a Polish plant geneticist who works for FAO at the Crop Research and Introduction Center at Izmir, Turkey. Dr. Zagaja roams the Turkish hillsides, fields, and valleys searching for wild fruit, cereals, grasses, and flowers. (Although flowers are not a food, the sale of flowers is big business and provides much-needed foreign credits.) Dr. Zagaja's pleasant hunting may provide a species of rice, wheat, barley, or other plant with genes for drought resistance, having lived for thousands of years in a dry valley, or one that produces high yields in mountainous areas with short, cold days. Dr. Zagaja is one of a small band of unsung heroes who are quietly assuring that we have enough to eat fifty years from now.

Breeding and hybridization of plants is not restricted to the needs of underdeveloped countries. In January, 1968, three members of the Department of Plant Science at the University of Manitoba reported the successful fusion of a high-yielding durum wheat

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(*Triticum durum*), with a variety of *Triticum aestivum* noted for its bread-making characteristics. Because of the ever-increasing demand for factory-made bread and the need to produce hundreds of thousands of loaves at a time, a flour should have a particular consistency that can be maintained over the entire mixing period. The high quality obtained by the crossings is attributed, at least in part, to the higher protein content of the flour. In the future, scientists will be called upon to develop plants to meet needs we do not yet recognize.

Here, then, are examples of what advanced scientific and technical skills can accomplish, given time, money, and skilled professional personnel. Eventually, higher-yielding strains of other crops will be developed—let us hope, in time.

It has long been obvious that *adequate and dependable supplies of water* are basic to any scheme for increasing crop yields. Fertilizers, pesticides, and high-yield seeds mean nothing if water is in short supply. Not only has water supply been a bone of contention between countries of the Middle East; right here at home, the states of California, Colorado, and Arizona have fought bitterly for the dwindling supplies.

Decisions by Congress will affect the development of water projects and the economic growth of seventeen western states for the next forty years. Each of these states needs larger and larger volumes of water to irrigate crops and meet ever-increasing domestic and industrial needs. While this problem is much the same in less developed areas, the money and engineering skills needed to develop existing sources are not generally available.

In the arid lands of the Middle East, water is the one sure factor limiting agricultural productivity. With an adequate supply of fresh water, making deserts “bloom” becomes a reality. As a result of extensive hydrologic surveys conducted by both the French and Algerian governments, a vast fresh-water lake was found under the Sahara stretching some 500 miles south from the Atlas Mountains. Utilization of this water has allowed a field of wheat to grow in what, just a short time before, was withering desert. In most, if

not all, developing countries a stable and regular water supply must come before any substantial increase in productivity.

The type of planning required for adequate supplies of fresh water is seen in Figure 24, in which hydraulic engineers have built a model of a dam before actually constructing it in Iran. The benefits of available water can be seen in Figure 25, where a field worker siphons water to feed a cotton crop in a newly created Irrigation District in Mexico.

Closely tied to the need for water is an efficient drainage system to remove the excess water that accumulates in the rainy season. Storage of this water provides a supply during the dry season, permitting not only one crop but double or even multiple crops in a year.

The Aswan High Dam on the Nile in Egypt, though as yet only partially built, made it possible to harvest three cotton crops in 1967 instead of one, and, in spite of a severe plague of locusts that descended upon the cotton fields, the additional two crops provided a bountiful harvest. This was a result of international politics. The Soviet Union, wanting an expanded sphere of influence in the Middle East, provided the hundreds of millions of dollars and trained personnel needed to construct the Aswan High Dam. In return, Egypt mortgaged the greatest portion of its main cash crop, cotton, for years to come.

Most underdeveloped countries need major hydraulic construction such as pumping stations and drainage and irrigation systems to increase their water supplies. Such sizable undertakings require enormous outlays of capital. Unfortunately, the enormous financial and technical aid needed to carry out engineering feats of this size is not usually readily available. Few of the developed countries have volunteered singly or in combination to help alleviate the critical needs for water.

On a much smaller scale, an aid agreement between the United States and Indonesia was announced in February, 1968. The United States agreed to loan Indonesia \$35 million at 2½ per cent for the purchase of rice, cotton, and Bulgar wheat. The loan would be payable within thirty years, including an additional ten-year grace

Figure 23. With the aid of an expert on field crops, a Libyan farmer weighs an experimental barley crop to determine seed productivity. Photo courtesy of FAO-UN.



Figure 24. Engineers with FAO in Iran discuss a model of a dam that when constructed will increase soil fertility in the area around it. Photo courtesy of FAO-UN.

Figure 25. This Mexican farmer is siphoning water to irrigate a growing cotton crop. Photo courtesy of FAO-UN.



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period. In effect, this long-term, low-interest loan means that the Indonesians do not have to repay it for at least a generation. After that, should they care to, the loan could be renegotiated for another generation. It is hoped that by then Indonesia will be economically independent and able to repay. A few months earlier, a loan of \$25 million was given Indonesia to permit purchases of spare parts and raw materials. Although there is an immediate need for the rice, wheat, and cotton, in the long run the importation of spare parts will be of greater benefit as it allows the farmers to upgrade their own agricultural efforts. Imports of food, on the other hand, are only stop-gap measures that cannot be indefinitely continued and do nothing to help achieve economic stability and independence.

According to conservative estimates, one fifth of the world's annual food crop is lost to insect depredations. Calculated another way, it is found that 10 per cent of all the world's harvested grains are destroyed in storage or made inedible by insects and other pests.

The idea or concept of a pest is original with man. Of the nearly a million species of insects that entomologists have catalogued, some 900 to 1,000 species prey upon men, animals, or plants. Because of their feeding habits, we call them pests.

In addition to insect and microbial pests, there are animal pests. One of the most notorious is the rat, some half-dozen species of which vie with man for the available food supply around the world.

In a country such as India, where the margin of scarcity is small, substantial losses to all manner of pests can mean the difference between eating and going hungry. In 1968, Food Minister Jagjivan Ram told his parliament that rodents destroyed more than 9 per cent of the food while still in the field. He said that loss of food to rodents and additional loss during handling and storage could well reach 10 million tons a year! It is difficult to give this a dollar equivalent, but a recent estimate places the annual loss of food crops in the United States alone at \$3 billion. On a world-wide basis, the figure would indeed be astronomical!



Figure 26. A mud silo common to many regions of Africa. They offer little protection to stored food from the incursions of rats and other pests. Photo from Freedom from Hunger, courtesy of FAO-UN.



Figure 27. Inverted wicker baskets suspended from poles are another common method of attempting to store food between harvests. Photo from Freedom from Hunger, courtesy of FAO-UN.

In certain areas of Africa and Asia, food is stored on earthen floors of clay and mud silos, such as the one pictured in Figure 26. Of course, food stored in this manner is ready prey for the burrowing rats and other rodents that abound in the vicinity. Another type of local storage can be seen in Figure 27, which shows inverted woven baskets containing the "excess" food, mounted on poles.

In an attempt to provide cheap, easily handled storage facilities, an inflatable plastic "balloon" warehouse has been developed. It is portable, fumigatable, and moisture-proof and can house 5,000 tons of bagged rice.

In countries where masses of people live close to starvation, losses of less than 5 per cent can create famine. Losses from pests can also outweigh the hard-won gains obtained through use of fertilizers, irrigation, and improved seeds. To avoid or reduce the losses requires highly sophisticated technical skills: breeding resistant plants, developing specific chemical pesticides, employing one species to combat another (biological control), or treating certain foods with ionizing radiation.

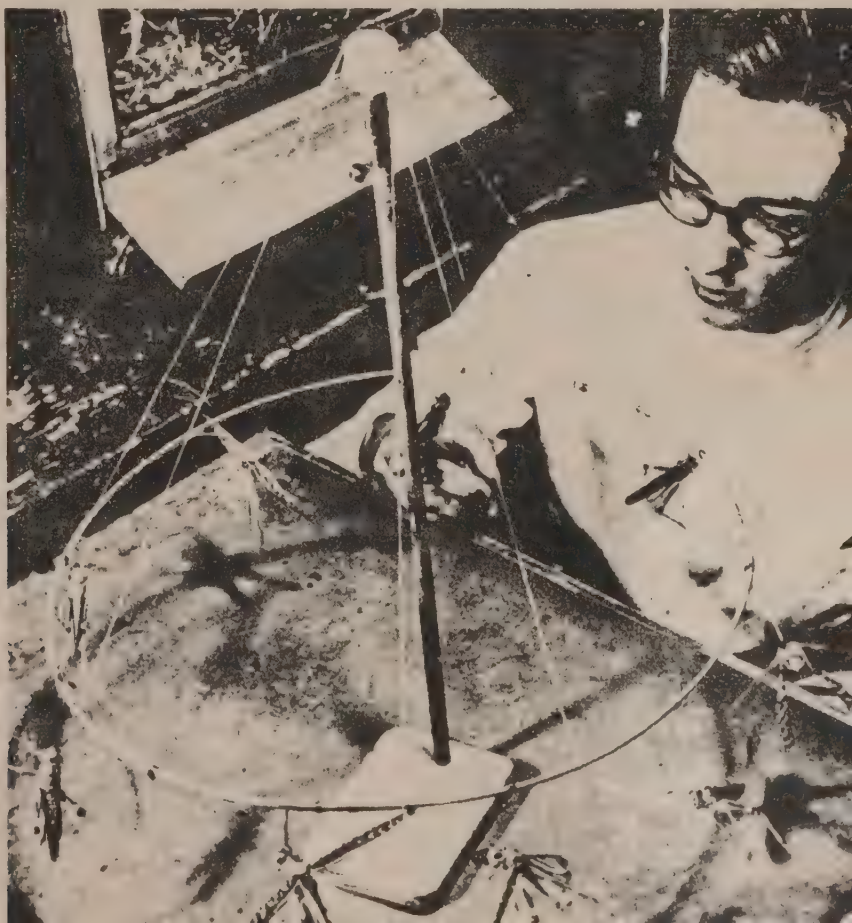
The application of chemical insecticides is by far the most widely used method to combat pests. Although insecticides must usually be imported from developed countries at considerable cost, they have *now* value. The other procedures, while having shown themselves to be effective, require professional scientists, time, and money.

The commonly used insecticides such as the chlorinated hydrocarbons, Benzenehexachloride (DDT) and the organophosphorus compounds, represented by Parathion, Malathion, and Diazinon, are undoubtedly the insecticides of choice *now*. They are well established, with proven ability against a host of pests, not the least offensive being the locusts, so common in Africa and the Middle East since Biblical times. Figure 28 shows farmers in Morocco combating a locust invasion with poisoned bait. Attempts to defeat the age-old ravages of plagues of locusts are being carried out for the first time by several countries working together. A scientist in Iran, for instance, tests the resistance of insects to various insecticides. Figure 29, shows an English scientist experimenting with locusts in an attempt to estimate speed and duration of their flight



Figure 28. An invasion of locusts in Morocco being fought by the spreading of poisoned bait. Unfortunately, this type of treatment usually fails to save the crop. Photo courtesy of FAO-UN.

Figure 29. The suspended ring is used by this scientist to measure the duration and speed of flight of locusts. Photo courtesy of FAO-UN.



as locusts suspended from a ring begin to "fly." In this way estimations of their flight speed and duration can be ascertained, again, this takes a good deal of time and the effort of well-trained personnel.

Chemical attractants obtained from the insects themselves are being developed as biological insecticides. The sugar beet wireworm is a pest that eats a wide variety of crops, including sugar beets, corn, potatoes, lettuce, and onions. The adults, called click beetles, characteristically jump several inches into the air while emitting a loud clicking sound. Scientists at the Entomology Research Division of the U.S. Department of Agriculture have extracted and purified the chemical that normally attracts male wireworms to the females. By placing this sex attractant in traps, males are lured to the traps and killed. Sex attractants, as a group called *pheromones*, are being increasingly used to trap and destroy a variety of insects. These chemicals it is hoped, will not affect the health and well-being of man, and they are more easily decomposed by soil and water microorganisms than the more commonly used insecticides. They should have an interesting future.

Perhaps in the next five years additional resistant plants will also be developed, along with more effective chemical pesticides. But—and this is important—whether or not the farmer uses these new products depends on two factors: his educational and cultural level and his finances. If the farmers do not accept and use the new developments, they are worthless.

Here, then, is another formidable problem directly related to food production: general education. Perhaps at this point the interrelationships of life begin to be a little clearer. Perhaps the reasons why change is so difficult to bring about can be better understood after reading Chapter Six.

Chapter Six

But Will They Eat It?

CURIOUS as it may seem, the work of anthropologists often makes the difference between success and failure in programs seeking to alter the food patterns of people who live according to strict religious and cultural rituals and taboos.

What do anthropologists know about the difficulties of feeding large populations? The need would seem to be for food scientists—engineers, technologists, nutritionists, and dieticians—professionals specifically trained to deal with food processing, handling and preparation. Anthropologists are not equipped for this, true, but they know a great deal about the habits, rituals, and beliefs of population groups. And since it is sometimes necessary to alter age-old established patterns and strongly held beliefs, it is folly to attempt such changes as developing new foods without knowing as much as possible about the prevailing culture.

In 1957, two scientists at the National Institutes of Mental Health published an account of a strange new disease confined to the northern highlands of New Guinea. Kuru, a Melanesian expression for the shivering or trembling usually accompanying cold or fear, was the name of this illness, and it accurately described its manifestations. Another sign of kuru was a laughlike grimace caused

by loss of control of certain facial muscles; this prompted some irresponsible journaists to dub kuru the Laughing Death.

Strangely enough, although kuru is limited to the Foré tribe, it was soon noted that the illness is largely confined to the women, those of eighteen to thirty-five years of age in particular. Although kuru was diagnosed as a disease of the central nervous system, brain, and spinal cord, no one knew how it gets started or how it is transmitted. Strong suspicion was focused on a virus as the culprit.

One of the first questions raised by the investigators was, Why the predilection for young women? Anthropologists, consulted for background information that might be helpful, indicated that, when a member of the tribe died, it was usual to eat the victim—including the brain. The men had less to do with this cannibalism, believing that eating friends and relatives weakened their manliness. The women, on the other hand, had no such inhibitions. The implication was clear. If the brain did in fact harbor infectious virus particles, and the women ate the brain, then their uniquely high incidence rates could be understood.

The relationships between food, culture, and disease become readily understandable when they are pointed out. The relationships between food, culture, and malnutrition are not easily uncovered. But social anthropologists can suggest where to look. Their knowledge often forestalls disastrous results by permitting food scientists to incorporate into a food program those things known to be acceptable to the people they are trying to help. It was just such planning, based on knowledge of the cultural patterns of Guatemalan Indians, that alerted scientists to build into Incaparina the familiar and acceptable odor of corn to lessen resistance to this new “drink.”

In Puerto Rico, borderline nutritional deficiencies of vitamin A, protein, and calcium were widespread. Attempts were made by the Nutrition Committee of Puerto Rico to increase the consumption of locally available breadfruit and imported canned milk that together could readily supply these nutriment. (Breadfruit, a member of the family Moraceae that includes the mulberry, fig, and Osage

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orange, was the tropical plant for which Captain Bligh made his now-famous voyage to Polynesia.) Soon it became apparent that the people most in need of the supplementation were simply avoiding these foods, and anthropologists were asked for help. They learned that breadfruit was taboo; local lore held that to eat it meant blindness or death with the eyes open, a fear widespread among primitive people. The canned milk was rejected because no one believed that milk in such a strange container came from cows. Why should they believe that it did? Consider for a moment what your own reaction might be if, without previous experience a stranger handed you a sealed can and told you it contained cow's milk and that it was good for you and your baby. Knowing little if anything about evaporated or powdered milk processing, would you be quick to drink it or better still, feed it to your baby? I should think not. The fact is, it took fifteen years of steady work among these people to break through their cultural barriers, primarily with the younger people who were not so rigidly bound to the "old" ways. Today, breadfruit and evaporated milk are widely accepted in Puerto Rico. A visitor to any small village would never suspect that not too long ago storekeepers would not allow these items in their shops.

In many areas of the world the foods people eat are a reflection of prejudice, ignorance, and simple availability. In Siam, Indochina, and parts of India, spiders are considered a treat. They are quite high in protein, but most Americans and Europeans would shudder at the thought of eating either spiders or insects, even though grasshoppers, locusts, and crickets, for example, are clearly specified in the Old Testament as being "clean" and therefore edible.

Similarly, in countries where monkeys abound, they are part of the local diet. Again, few Europeans or Americans could be induced to taste them, however disguised. Looking at the other side of the coin, eggs, milk, and oysters, which many of us consider first rate, are in fact revolting to Africans and Asians.

For example, although chicken and eggs are in good supply and are readily available to many tribes in Nyasaland, African women there will not eat them for fear they cause bald-headed babies.

Similarly, children are often prevented from eating eggs because custom holds that bladder disease, sterility after marriage, and greediness are directly related to egg consumption. Thus it is difficult to increase the general use of these high-quality protein foods that are locally available. Chickens and eggs are raised in these regions chiefly for the money they bring when sold to others.

India also has egg and chicken taboos. Young boys and young mothers in West Bengal are not allowed to eat eggs because they are believed to be weakening.

In the past, attempts to change these patterns have met with hostility and indignation. More recent attempts, taking cultural variations into account, have been more successful. The young girls seen in Figure 30 are learning to use what is to us a simple stove; it is planned that they will return to their respective villages in Indonesia and teach others how to build such stoves and cook with them.

The point that must be emphasized here, is the level of primitiveness being dealt with. We are not talking about bringing knowledge of advanced technology, such as the maintenance and repair of refrigeration equipment, but simple wood-burning brick-and-mortar stoves.

In Figure 31, girls from the Cauca region of Colombia are being taught hygienic habits of cooking, and in Figure 32 young girls in Leopoldville are taking instruction in the preparation of chicken. Perhaps these examples will indicate the types of help needed.

Food taboos are not restricted to underdeveloped countries. Members of the Jewish and Mohammedan faiths have followed their Biblical and Koranic injunctions against eating pork and pork products for thousands of years. The fact that this has rendered them free from trichinosis as compared to pork-eating populations is an unexpected but welcome benefit.

Although Protestants the world over impose no food injunctions on their members, most follow accepted Western patterns of obtaining their meat from the cow, sheep, and pig and avoid insects and horse meat.



Figure 30. Young Indonesian girls are taught to use a simple brick stove. Photo courtesy of FAO-UN.



Figure 31. Girls of the Cauca district of Colombia are taught to prepare food in a hygienic manner. Photo courtesy of FAO-UN.



Figure 32. These young women in Leopoldville are learning to prepare chicken for home meals. Photo courtesy of FAO-UN.

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For a thousand years Catholics have been enjoined from eating meat on Friday. When the ecumenical council removed this injunction, many Catholics could not forego the age-old proscription, and they continue to avoid meat on Friday. Hindus studiously avoid eating beef and beef products. The idea of the "sacred cow" has caused many an economic planner and food expert absolute despair; the thought of starvation in the midst of plenty simply was intolerable. But hungry people will not, contrary to what some people say, eat anything placed before them; nor should they be forced to.

That a large part of what we eat or do not eat is psychological, meaning that the reservations we have are mental rather than physiological, is well illustrated in the following anecdote ascribed to Marston Bates, Professor of Zoology at the University of Michigan: A fashionable Frenchwoman attended a sumptuous dinner in Colombia, South America. Her host studiously avoided naming the various foods being served, but many comments suggested that the dinner was indeed delicious. After the meal, the Frenchwoman, who was used to good food and who had eaten well, asked the name of the matchless white meat that been served as an entree. "Lizard," replied the host. "A lizard!" she exclaimed, and fainted dead away.

In previous chapters, we pointed out that attempts to cope with hunger, undernutrition, and malnutrition have to contend with established food patterns and that to try to change or alter these patterns requires a large expenditure of time and money. Certainly, trying to change entrenched cultural beliefs has little *now* value.

We have listed the high-quality animal protein foods as milk, meat, fish, eggs, and cheese. In our view, milk and cheese means cow, and eggs mean chicken—the hen—and meat usually means sheep, pig, cow, and sometimes deer. It seems incredible that of the two million animal species known only fifty are domesticated, only three eaten with any regularity in the United States, Canada, and Europe. While a fair amount of horse meat is included in the French diet, it is not eaten elsewhere in Europe unless great hardship prevails, as it did during the grim years of 1941–1945. Obvi-

ously then it takes a catastrophe of the magnitude of World War II, to force a change in diet. When the period of hardship passes, the population most often reverts to its previous diet.

Protein, carbohydrates, calories, and other nutrients can come from dogs, cats, crocodiles, camels, hedgehogs, kangaroos, antelopes, whales, elephants, wolves, snakes, eels, and monkeys, as some people suggest they should. Certain questions, however, are pertinent, apart from the desirability of eating these animals. Are they available in sufficient number to provide a reliable and regular source of supply? If not, can they be domesticated in the style of cattle to provide a stable food supply? Do we know enough about the nutritional needs of each of these species to provide forage the year around and maintain production of high yields of meat? Many years of trial and error, followed by rigorous scientific experimentation at many university experiment stations, were needed to obtain the information on animal nutrition that led to increased yields of meat from cattle, pigs, and sheep, and many years of careful development were required to upgrade milk production in the cow. The hard fact is that we know next to nothing about the water buffalo, kangaroo, and crocodile, aside from getting widescale acceptance of using these as food animals.

It is worth noting, too, that while rats and other rodents (squirrels and rabbits) are in good supply and are considered good eating in a few countries, they do not figure in any schemes to upgrade the protein supply.

Several years ago, Dr. Edward Wellin, a cultural anthropologist studying mother and infant feeding practices, went to live in Espinos, a small village in the Ica Valley on Peru's south-central coastal plain. Dr. Wellin was seeking answers to two questions: What nutritional practices are associated with early infancy, pregnancy, and lactation, and what cultural taboos direct them? His published observations make fascinating reading and provide direction and guidance for those concerned with upgrading the nutritional status of people with entrenched food habits.

It didn't take Dr. Wellin's trained eye very long to discover that two major dietary patterns contribute to malnutrition of mother

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and child in Espinos. For at least a year, the child's diet is rigidly restricted to milk and a little sugared water or herb tea. Curiously enough, Espinos is located in an area that produces a wide variety of fruits and vegetables which, if incorporated into infant foods, could quickly modify the malnutrition, but custom prevailing, they are strictly forbidden. During this same period, the mother also abruptly and strictly reduces her intake of food, consuming less meat, and eggs, fruits, and vegetables and more corn, rice, squash, beans, and soups. In effect a self-inflicted state of protein-calorie malnutrition is initiated and carried on during one of the most sensitive periods of child development and parental need. The severe lack of fruits and vegetables for both mother and child has the added effect of restricting the intake of much-needed vitamin A (found in carrots, kale, collards, sweet potatoes, broccoli, okra, and apricots). Dr. Wellin gives the reasons for these dietary restrictions:

The infant organism is conceived to be delicate, to "lack resistance," and solid foods, even semi-solid paps, are feared to be "too strong" for the assumed frailty of the stomach and organism. The prime need of the first months is assumed to be that of gradually building up the infant's resistance so as to enable him later to withstand the ingestion of solid foods. This build-up is felt to be accomplished through an unsupplemented milk diet.

Dr. Wellin goes on to say:

certain ideas about milk and its relation to other foods and the body are also implicated. Though milk is regarded as the only appropriate food for infants, its use is ringed with precautions. By itself, it is felt to be a "good" food; when consumed in combination with many other items, it is regarded as a potentially harmful one. Specifically, drunk before or after nearly all fruits, sweets, "heavy" foods or "cold" ones, milk is believed to produce antagonistic internal mixtures and "bilious" reactions. The infant stomach is said to be

ill-equipped to tolerate either the hostile mixtures or the accompanying bilious attacks.

As to her own diet, the mother is equally certain that the foods she eats will have a profound effect on her health and on her baby's. Strange as it may seem, it is just this strict adherence to rigid cultural patterns that gives rise to the protein and vitamin deficiencies so often seen in these villages.

Dr. Wellin's findings about the taboos surrounding "hot," "cold," and "heavy" foods is of considerable interest. He found that:

village culture has provided the mother with certain bedrock convictions about food. She believes that some foods are "hot," some "cold" and that others are in an intermediate hot-cold range. These distinctions have little to do with actual temperatures but refer primarily to convictions as to the innate qualities of foods and their effects on the organism. She also distinguishes between "light" and "heavy" foods. Items with high starch and low water content are usually but not in all cases heavy. Also heavy are other foods believed to have perverse digestive qualities or stomach-fouling properties. In general, light foods are those which are simply "not heavy" as well as others believed to have indifferent nourishment value.

The basis for avoiding or eating "hot" and "cold" items was also uncovered. "The prohibition," he found, "on eating extremely hot items—chocolate, alcohol in any form and most condiments," appeared to be preventive in nature.

Hot foods are said to aggravate the heartburn that goes with pregnancy. Also, their innate heat is believed capable of activating the uterus and inducing premature birth or abortion. During lactation, consumption of hot foods by the mother transmits a hot quality to the breast milk, which then becomes too great a stimulant for the infant . . . as for cold foods, some are completely avoided, such as pork and watermelon . . . cold foods—more accurately, their innate cold qualities—are profoundly feared. Cold is believed capable of

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lodging in the organism of mother, fetus or infant and of wreaking harm even long after it has entered. It is supposed to act as a diffuse depressant and often figures in folk etiologies of pneumonia and tuberculosis. Besides being antagonistic to the mother's delicate state, cold is feared to be transmissible to the fetus via the placenta and to the infant through breast milk.*

An attempt was made by the district health department to introduce such modern concepts of nutrition as vitamins: the foods in which each is found and their values. The success they had may be measured by the fact that the villagers of Espinos redefined their understanding of "cold" and "hot" foods (which has nothing to do with temperature) but did not change this classification. Dr. Wellin reported that "they regard vitamins as inappropriate for pregnant women and even less suitable for babies. Vitamin-laden foods are too "strong" for infants; at the same time, they are too fattening for the pregnant."

Although the malnutrition fostered by cultural patterns in the Ica Valley of Peru is not sustained and does not often lead to death or disfigurement, some eighty thousand children in many countries do become blind—and half of them die each year because of faulty nutrition. Lack of vitamin A is responsible for xerophthalmia, the most widespread cause of blindness of nutritional origin in the world today, which always produces some permanent damage to the eyes.

The earliest sign of vitamin A deficiency in man or experimental animals is night blindness; this is usually followed by loss of weight and decreased resistance to infection. There is a generalized drying and scaling of the skin (technically called *keratinization*). In extreme cases, the skin becomes so rough it resembles the skin of a toad. When the tear glands become involved, xerophthalmia occurs. Its most obvious signs are white foamy patches in the cornea (Bitot's spots) followed by bleeding and ulceration that can lead to total blindness. The Lebanese infant shown in Figure 33, although ap-

* From the *Journal of American Dietetic Association*, September, 1955.
Used by permission.

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pearing robust after proper nourishment, has dense corneal scars of both eyes as a result of prolonged malnutrition.

Whereas the largest natural sources of vitamin A are found in cod, shark, halibut-liver oils, eggs, and butter, vitamin A is also found in the dark, leafy, and yellow-orange rooted vegetables and tubers. Stores of vitamin A are maintained in the liver and used as needed. When dietary intake of the vitamin is sharply reduced or is nonexistent, the liver becomes depleted of its store and symptoms of the disease begin to appear. Infants born with a low reserve because of their mothers' inadequate intake are poorly equipped to meet the heavy demands for vitamin A during the very rapid growth phase of early infancy. Where, as in the villages of the Ica Valley, foods of high vitamin A content are withheld or, as in other countries, are unavailable, acute deficiency symptoms rapidly occur. Thus there is ample reason for the finding that in

Figure 33. This Lebanese child, recovered from xerophthalmia, has permanent scars on both eyes that mean permanent blindness. From "To Eat, To See" by Donald S. McLaren in *Nutrition Today*, March, 1968.



the less-developed countries the greatest proportion of blindness occurs in the younger age groups. In addition, the fixed cultural patterns in many underdeveloped countries, but particularly in Africa, specify that productive men of the family are given the first share of any available food: children and women follow in that order.

As the entire body becomes weakened by the lack of adequate foods, and its natural defenses are disrupted, microbial infections occur with greater frequency due to the disruption of natural defense mechanisms. This means that when a bacterial or viral disease strikes this already nutrition-starved system, in one out of two cases, it can cause the death of an infant or preschool child.

Figure 34 shows the world-wide distribution of xerophthalmia. Although the United States is not depicted on this map, do not assume that the disease could not occur here. The fact is that literally thousands of children who do not yet show the symptoms of severe vitamin A deficiency "are poised on the brink of nutritional disaster and it only requires some special stress to precipitate overt disease," according to Dr. Donald S. McLaren, writing in *Nutrition Today*.

A striking example of an attempt to introduce an exotic item into areas that do not generally eat such "food" can be seen in the work of Rudyard Boulton. Termites have been called African caviar by adventuresome gourmets, but it is unlikely that termite steaks or termite pudding will replace sirloin or Jello. However, Rudyard Boulton of the Atlantic Foundation Ecological Research Station near Salisbury, Rhodesia, is trying to develop food products made of termites that will aid in alleviating protein malnutrition. Termites apparently are well stocked with protein, but the very fact that they are termites seems to preclude their acceptance by many people—even the hungriest.

The decision on the part of an individual or group to adopt a new idea usually takes considerable time. In a unique book, *Adoption of New Ideas and Practices*, which should be required reading for everyone concerned with attempts at altering behavior, Herbert F.



Figure 34. World-wide distribution of xerophthalmia. From "The Prevention of Xerophthalmia" by Donald S. McLaren in *Pre-School Child Malnutrition* NAS-NRC, Washington, D.C., 1966.

Lionberger spelled out the phases people pass through on their way to adopting or rejecting a new idea. He noted that usually new ideas are not readily accepted; most often people wait several years after hearing about a new idea before trying it and much longer before permanently adopting it.

To be sure, some decisions are made quickly—but many others require extended thought and deliberation. The final decision to use a new practice is usually the result of a series of influences operating through time. For many practices people appear to go through a series of distinguishable stages:

Awareness—the first knowledge about a new idea, product or practice.

Interest—the active seeking of extensive and detailed information about the idea to determine its possible usefulness and applicability.

Evaluation—weighing and sifting the acquired information and evidence in the light of the existing conditions which the practice would have to fit.

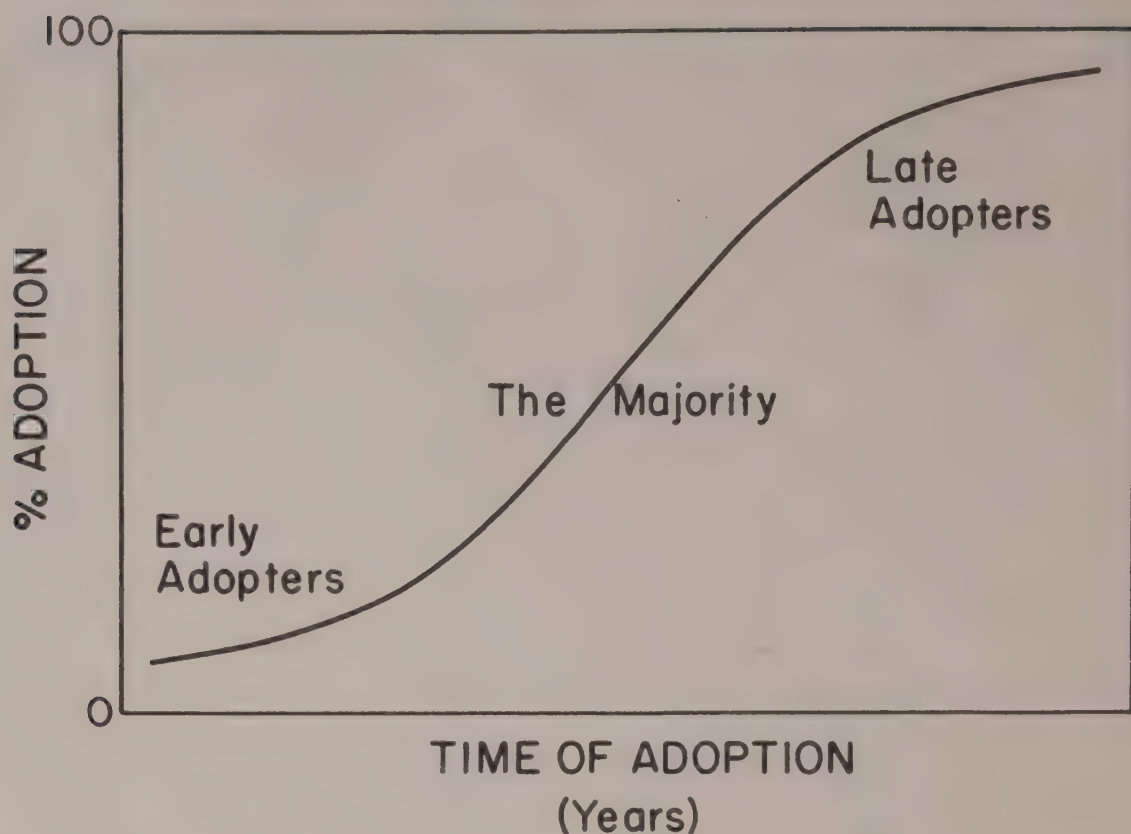


Figure 35. The ease of adoption of new ideas is seen as an S-shaped curve, which implies that individuals are slow to take on new ways. From *Adoption of New Ideas and Practices* by Herbert Lionberger, © 1961 by the Iowa State University Press, Ames, Iowa.

Trial—the tentative trying out of the practice or idea accompanied by acquisition of information on how to do it.

Adoption—the full-scale integration of the practice into the on-going operation.

Dr. Lionberger indicates that the type of people, their habitat, and the particular practice that one seeks to alter will together affect the length of time between first learning of the idea and final adoption.

Figure 35 shows that most people do not take to a new idea quickly. As an interesting example, Dr. Lionberger noted that “at least 20 years have elapsed since the practice of applying fertilizer according to soil test was first recommended and adoption still is not complete.” This is in the United States, in the waning years of the twentieth century among people who have lived all their

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lives amidst technological developments. What then can be expected of people living in primitive agricultural societies? It bears repeating that although attempts to modify and change food habits are certainly in order, they have long-term rather than *now* value. Attempts to alter food selection patterns quickly in order to relieve hunger and malnutrition will meet with little success.

Chapter Seven

Hope: Now or in the Future?

“**T**HE MISERY of much of the developing world is a progressive misery that threatens to grow worse in the next five years.” With these words, U Thant, Secretary-General of the United Nations, implied that in spite of the enormous technical aid in money, supplies, and manpower given by the more advanced nations, the underdeveloped countries are falling farther and farther behind in their ability to feed themselves.

FAO has estimated that food supplies in these countries will need to be increased 80 per cent by 1975 and almost 300 per cent by the year 2000, if improved levels of nutrition are to be achieved. Even the most optimistic planners find it difficult to see how these higher levels can be obtained. Small wonder then that predictions of world-wide famine by 1975 are appearing with increased frequency in newspapers and periodicals.

To give these ideas substance, Table VI* may be helpful. These figures, developed by Dr. Grace A. Goldsmith, Dean of the School of Public Health and Tropical Medicine, Tulane University, may

* Through courtesy of Dr. Grace A. Goldsmith. Presented at the 95th Annual Meeting of the American Public Health Association, Miami Beach, Florida, October, 1967.

Table VI

ANNUAL GROWTH RATES REQUIRED IN DEVELOPING COUNTRIES TO BALANCE *DEMAND* WITH *NEED* FOR FOOD BY 1985

	<i>Percentages</i>	
	<i>Present</i>	<i>Required</i>
Increase in food demand	3.0	4.0
Increase in food production	2.7	4.0
Increase in gross national income	4.5	5.5
Capital investments (Per cent of GNP)	15.0	19.0

prove deceptive to those unfamiliar with the dollar costs of increasing productivity by only one or two percentage points. They tell us that to achieve the 4 per cent annual growth rate in food demand noted in the table, capital investments must be increased 4 per cent, from 15 to 19 per cent of the Gross National Products of the underdeveloped countries. The painful fact remains that to accomplish this would require an increase of \$12 billion in investments in each country, using 1965 as a base. The realization that figures of this order of magnitude would be required in each of the underdeveloped countries is staggering.

The use of so strong a word as "staggering" can be understood when one learns, for example, that in the underdeveloped countries, food production annually loses ground to population growth. In South America, food production stood still in 1967 while population increased at the formidable rate of 2.7 per cent per year. For food production to balance the deficits of the past four years, it would have to increase by at least 7 or 8 per cent in the next two to three years, which is simply impossible.

A similar situation is shaping up in Asia. At a meeting of the Board of Governors of the Asian Development Bank, it was stated that the food supply of Asian countries is currently poised on the knife edge of inadequacy and will get worse. It was also noted

that by 1970 the region's demand for rice and other grains would undoubtedly exceed its production.

In previous chapters, we discussed developments that could be placed on the credit side of the food balance sheet. Each of them—fertilizers, improved seed quality, protein supplementation, irrigation, aquiculture, insecticides, modifications of taboos, and others—may aid in increasing food yield by some increment; in combination they could probably do a good deal better. Each of them may not be suitable in all countries. Some may be more applicable in one area than another, and one or two may have a great deal more potential and promise than the others. If these are reasonable assumptions, it would seem that there really is no great problem.

Unfortunately, what often appears at first sight to be a straightforward, uncomplicated solution may have many obstacles in its path, obstacles that can prevent its being readily carried forward, or even carried through at all.

A generous supply of educated, technically skilled men and women, if not the most important single factor needed to provide and ensure adequate food supplies, is surely close to being most important. Each year Japanese schools graduate some 7,000 agricultural scientists and technicians. In all of South America, fewer than a thousand are graduated. In Japan there is one farm advisor (akin to our county agent) for every 600 farms while in Indonesia there is one for 100,000 and in Colombia one for 10,000.

Technological development—modernization—is a slow process requiring the training of an army of men and women with the necessary technical skills to develop a country's own resources and industries. Unfortunately, it has little *now* value—but it has the greatest importance for the future.

In many of the underdeveloped countries there is no understanding of the simplest machines. Consequently, the most sophisticated equipment, the kind usually sent in by the industrialized nations, is often used only during the first few weeks of trouble-free operation. As soon as repairs are needed, the unit becomes obsolete

because there are no people with the necessary skills to make the repairs.

Similarly, underdeveloped countries want and get status symbols in the form of steel fabricating plants and nuclear reactors which they can not manage, again because of their crucial lack of trained manpower. These also represent wasted credit—when not received as an outright gift.

Let there be no mistake about it, the army of skilled workers needed in underdeveloped countries is not composed of theoretical scientists, but of the mechanics, carpenters, sheet-metal workers, refrigeration repairmen, electricians, and plumbers so vital to the functioning of any “advanced” community.

Another obstacle to adequate food supplies is the number and type of roads. Without access roads into and out of fields and major highways permitting rapid transportation of the harvested crops, farm produce remains in the local area and is unavailable for wide distribution. Here again many skills are needed, plus a large amount of money. Road building, as we in the United States have come to know, is a technical and expensive undertaking. Too many people fail to include this item when discussing the ease of upgrading food supplies.

Essential to many of the plans advanced for increasing agricultural products is the availability of water. Upon the lack of suitable supplies of water may hang the fate of many ambitious programs. Irrigation projects are extremely costly and for the most part difficult to execute. New sources of water must be found in underdeveloped areas.

It is also interesting to note that in many countries of Latin America, less than 20 per cent of the rural population has potable drinking water. Here, too, the expense of laying pipelines simply cannot be borne by the impoverished governments.

The Gross National Product, GNP, is a concise barometer of a country's productivity. An example may be helpful: In the seventeenth century, England with 5.5 million people and India with 65 million, had equal per capita incomes, or GNP. By 1960, Eng-

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land had 50 million people and India, 440 million. Their GNPs had altered just as dramatically; for each dollar of per capita income in India, England had \$16. England has no problems of malnutrition or hunger while India has one of the most pressing.

I am saying that it costs money to produce food. It is necessary to buy seed, fertilizer, machinery, and tools; to provide storage facilities and irrigation systems; to provide shipping and transportation facilities to move products to ultimate consumers. This money may not be easy to obtain for any sustained period. This may be another real obstacle.

In many areas of the world the system of small family plots has so divided up agricultural land as to make it wholly inadequate to produce the huge quantities of crops needed. To overcome this requires a radical change in culture and social structure. Culture being so difficult to modify or alter, one would not expect to see any great changes wrought in the short run.

In too many underdeveloped countries, where money is chronically in short supply, the few available dollars are exchanged for the latest in sophisticated military aircraft or missiles to bolster national pride. In the face of the unspeakable misery in which most of the population dwells, these purchases are difficult to countenance.

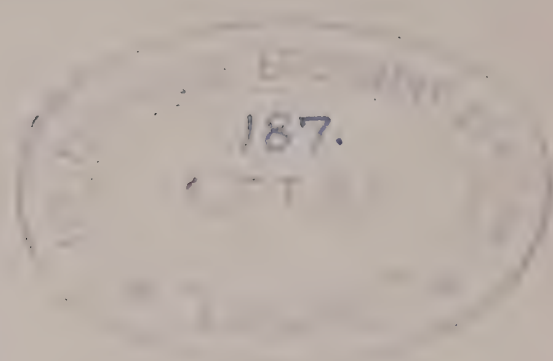
In his beautiful book, *Self Renewal*, John W. Gardner, (recently Secretary of the Department of Health, Education, and Welfare), related an anecdote full of meaning for the food-population dilemma. "A European agriculturist," he wrote, "speaking of the Indonesian peasants with whom he had been working, said to me recently, 'These people don't lack intelligence, they lack motivation. They don't find modern agricultural techniques so difficult; what they find difficult to absorb is our attitude that man can improve his lot by making an effort.' In any society," he went on, "there develops a more or less stable set of attitudes toward what is possible. These attitudes inevitably set ceilings for performance." Lack of motivation may in the long run be the biggest barrier to achievement. Perhaps this is where the greatest effort should be placed.

Hope: Now or in the Future?

At the close of the first meeting of Western Hemisphere nations at Punte del Este in April, 1967, President Johnson said, "We have learned much, and much that we have learned confirms the judgment of Ecclesiastes that he who increaseth wisdom, increaseth sorrow. Economic and social development is a task not for sprinters but for long-distance runners."

The fact is that there is a real race in progress. Unfortunately, it can have a grim outcome with no winners. If the race against hunger and famine is not won, we shall all be losers.

But hope springs eternal. According to the dictionary, to hope means to desire with expectations of fulfillment—and expectation of fulfillment can be a great motivating force.



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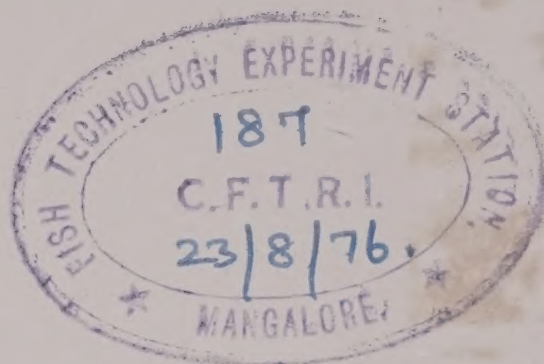
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It was during this period that Dr. Benarde's appreciation of the many faceted problems attendant on feeding hundreds of millions of people crystallized.



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